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Cover: Yellowfin tuna, photographed inside a purse seine by William L. High, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, Wash.

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A Review of the Yellowfin-Skipjack Tuna Fishery of the Atlantic Ocean and American Participation, 1956-75

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INTRODUCTION

Over the past 2 decades the tropical tuna, or combined yellowfin tuna, *Thunnus albacares,* and skipjack tuna, *Katsuwonus pelamis,* fishery of the Atlantic Ocean has increased from a few hundred metric tons in 1956 to approximately 174,000 metric tons in 1975 (Fig. 1). It is currently the largest tuna fishery in the Atlantic Ocean and supports an international fleet of more than 800 vessels.

The vessels employed in the fishery are mainly longliners, baitboats, and purse seiners. They range in size from a few metric tons to 2,000 metric tons in carrying capacity. Longliners generally fish well offshore with longline gear (Shapiro, 1950) and catch deep-swimming tunas of frequently large size. Baitboats employ the pole-and-line with live-bait chum technique (Cleaver and Shimada, 1950), and purse seiners employ purse seine nets (McNeely, 1961). Both baitboats and purse seiners operate relatively close inshore and purse seiners also operate far offshore. They capture tunas, frequently of small size, that occur near the surface. Because of this difference in the type of tunas exploited by the different gears, the fishery is often divided for convenience into a longline fishery, consisting of longliners, and a surface fishery, consisting of baitboats and purse seiners.

The longline fishery extends throughout the tropical Atlantic, whereas the surface fishery is concentrated primarily off Africa (Fig. 2). Some areas in the western Atlantic, such as in the Caribbean Sea and off Venezuela, support a small surface fishery that is probably underdeveloped (Juhl, 1971; Ramos and Guerra, 1976; Wagner, 1974).

In this report we review the development of the tropical tuna fishery of the Atlantic from 1956 to 1975, and discuss the current condition of the stocks. Special attention is given to analysis of data from the American[1] tropical tuna fleet because this fleet is a relative newcomer to the fishery but ranks fourth in total production. Data sources for this study are: ICCAT (1976a) for data on catch and number of

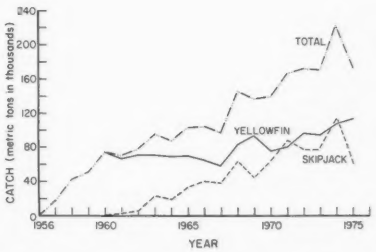
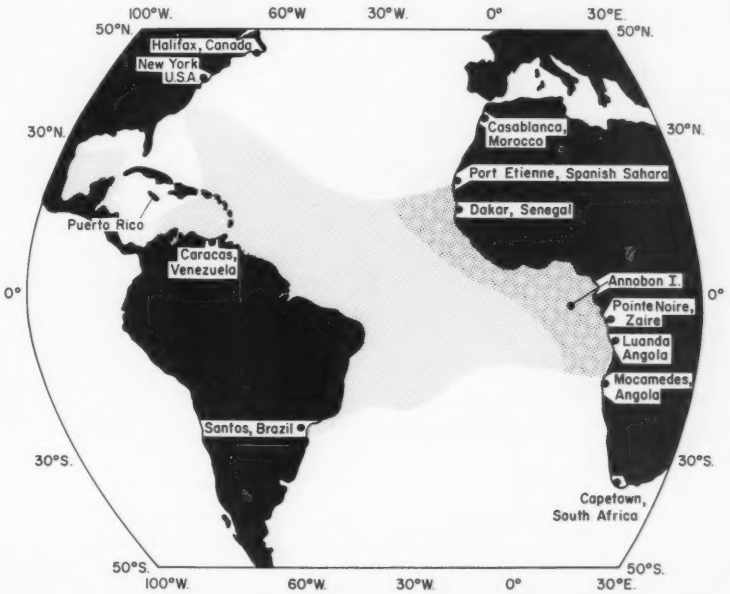


Figure 1.—Total Atlantic catches of yellowfin and skipjack tunas.

[1]The combined tropical tuna fleets of Canada, Netherlands Antilles, Panama, and the United States are monitored as a unit. "American" in this report refers to this combined fleet, which during 1968-75 consisted of at least 83 percent U.S. vessels.

Figure 2.—Areas in the Atlantic Ocean where the longline fishery and surface fishery (speckled area in the eastern Atlantic) for tropical tunas are concentrated.



fishing vessels; Fishery Agency of Japan (1968-75) for data on longline catch and effort; and ICCAT (1973a, b, 1974a, b, 1975a, b) for data on sizes of fish caught and catch and effort of the surface fleets.

LONGLINE FISHERY

The longline gear is particularly effective in catching pelagic fishes that are widely dispersed in the open ocean. It is a multispecies gear but can be deployed to catch more of one species than another. In longline tuna fishing, albacore (*T. alalunga*), bigeye (*T. obesus*), bluefin (*T. thynnus* and *T. maccoyii*), and yellowfin tuna are primarily caught along with incidental catches of billfishes (Istiophoridae and Xiphiidae). Skipjack tuna is normally not caught on longline gear.

Longline fishing for tunas in the oceanic regions of the Atlantic Ocean was pioneered by the Japanese in 1956. In that year a few Japanese longliners conducted test fishing for tunas off the northeastern coast of South America (Shiohama et al., 1965). Fishing was excellent particularly for yellowfin tuna, and in the following year the fishery began in earnest with 26 Japanese longliners fishing throughout the tropical Atlantic. Additional Japanese vessels entered the fishery each year thereafter until the Japanese fleet peaked at about 210 vessels in 1965.

The catch rates for the Japanese fleet were initially high but quickly declined as the fleet rapidly increased in size. This caused some vessels to withdraw from the fishery and some to be sold to foreign interests, primarily to South Korean and Taiwanese fishermen. A few new, more efficient Japanese vessels entered the fishery as replacements while the former Japanese-owned vessels were placed into service by the new owners. The Koreans and Taiwanese found fishing in the Atlantic to be profitable and quickly acquired and deployed more vessels. Consequently, the international longline fleet grew rapidly in the late 1960's and early 1970's (Fig. 3). Currently, more than 500 longliners participate in the Atlantic tuna fishery with about 50 percent belonging to Korean and Taiwanese interests, about 40 percent to Japanese interests, and the remainder to Brazilian, Cuban, Panamanian, and Venezuelan interests.

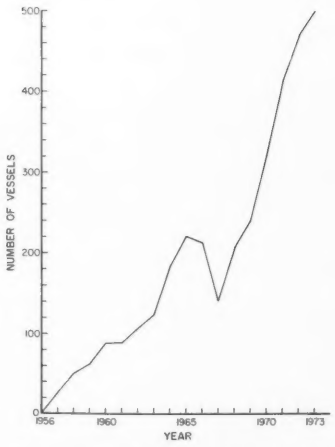


Figure 3.—Number of vessels in the longline fishery of the Atlantic Ocean, 1956-73.

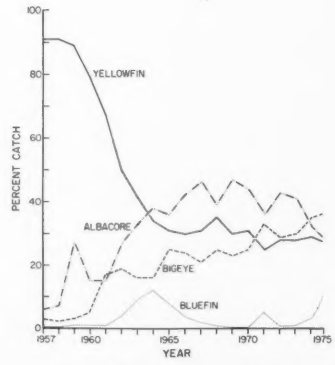


Figure 4.—Species mixture in the longline catch (tonnage) of the Atlantic Ocean, 1957-75.

Species Mixture

Before the mid-1960's, longlining in the Atlantic was primarily confined to tropical waters where the yellowfin tuna occur. Yellowfin tuna was the target species and contributed more than 30 percent of the total longline tuna catch (Fig. 4). The catch rate of yellowfin tuna, however, declined during this period and the fleet gradually shifted its operations to temperate regions in search of other species such as albacore and bigeye tuna (Shiohama et al., 1965). The species mixture of the catch, consequently, changed from primarily yellowfin tuna to primarily temperate tunas. Yellowfin tuna presently contributes less than 30 percent of the total longline tuna catch and albacore and bigeye tuna constitute more than 60 percent of the catch.

Yellowfin Tuna Catch and Catch Rates

Longliners were responsible for most of the catch of Atlantic yellowfin tuna before 1966 (Fig. 5); since then the surface fishery has produced most of the yellowfin tuna. The longline catch peaked at about 53,000 metric tons in 1960 and slowly declined to 21,000 metric tons in 1967. It then increased to about 30,000 metric tons in 1969 where it has remained.

More than 50 percent of the longline catch of yellowfin tuna was annually caught in the eastern Atlantic (east of long. 30°W) during 1957-64 (Fig. 6). About equal amounts were caught from the eastern and western Atlantic during 1965-69 and the bulk from the western Atlantic (west of long. 30°W) during 1970-75.

If there are two principal subpopulations (Honma and Hisada, 1971; Hayasi[2]), eastern and western subpopulations, of yellowfin tuna in the Atlantic Ocean, the longline catch rates suggest that the eastern subpopulation is more depressed than the western subpopulation (Fig. 7). The catch rate in the eastern Atlantic fell sharply from about 3.6 metric tons/1,000 hooks in 1958 to about 0.8 metric ton/1,000 hooks in 1962, and then gradually declined to less than 0.1 metric ton/1,000 hooks in 1975. In the western Atlantic it fell precipitously from about 3.3 metric tons/1,000 hooks in 1958 to about 0.7 metric ton/1,000 hooks in 1961 and then drifted lower to 0.4 metric ton/1,000 hooks in 1975.

[2]Hayasi, S. 1973. A hypothesis on population structure of yellowfin tuna in the Atlantic Ocean, mainly based on longline data. ICCAT Collective Vol. Sci. Pap., 2 (SCRS-1973), p. 40-48.

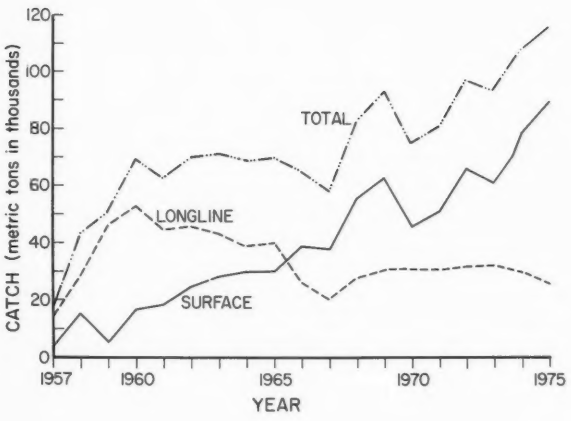


Figure 5.—Atlantic catches of yellowfin tuna for the longline and surface fisheries, 1957-75.

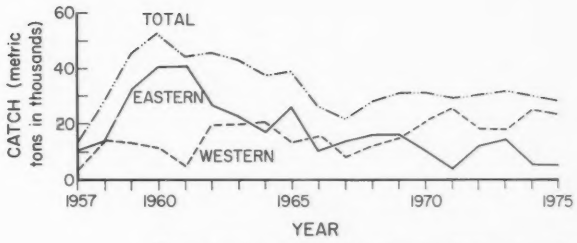


Figure 6.—Longline catches of yellowfin tuna from the eastern and western Atlantic, 1957-75.

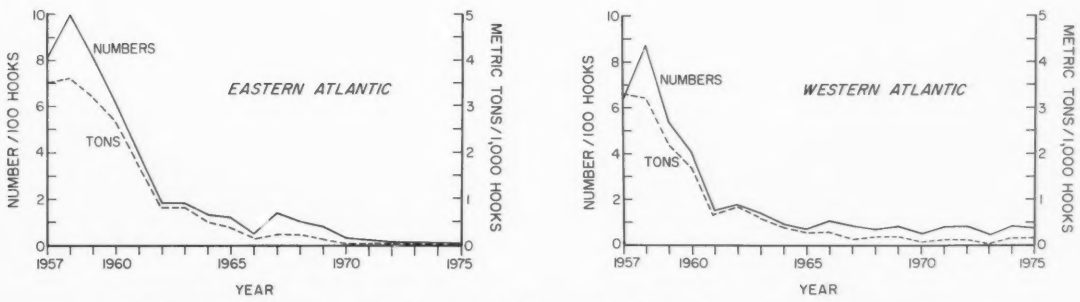
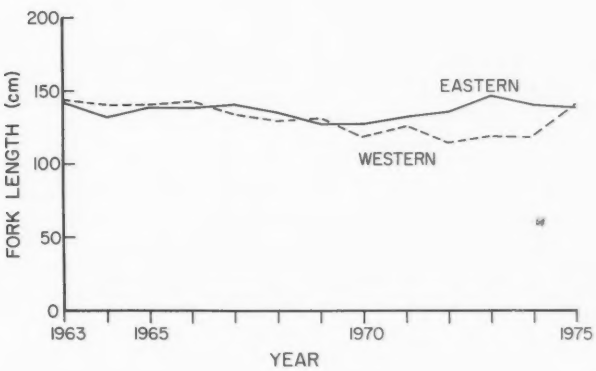


Figure 7.—Catch rates of yellowfin tuna for the Japanese longline fleet by eastern and western Atlantic.

Size Composition of Yellowfin Tuna

Before 1970, yellowfin tuna caught in the eastern and western Atlantic by the longline fishery were, on the average, about the same size (Fig. 8). Since the, the average size of fish caught in the western Atlantic has consistently been smaller. The average size of fish caught in the eastern Atlantic furthermore has remained quite constant despite the competition from the surface fishery that lands substantial numbers of large yellowfin tuna (>85 cm, Fig. 9). These data suggest the possibility that the longline and surface fisheries do not exploit the same stock (Lenarz and Zweifel, in press) and that in the western Atlantic the longline fishery is exploiting greater amounts of yellowfin tuna from the surface stock than the deep-water stock.

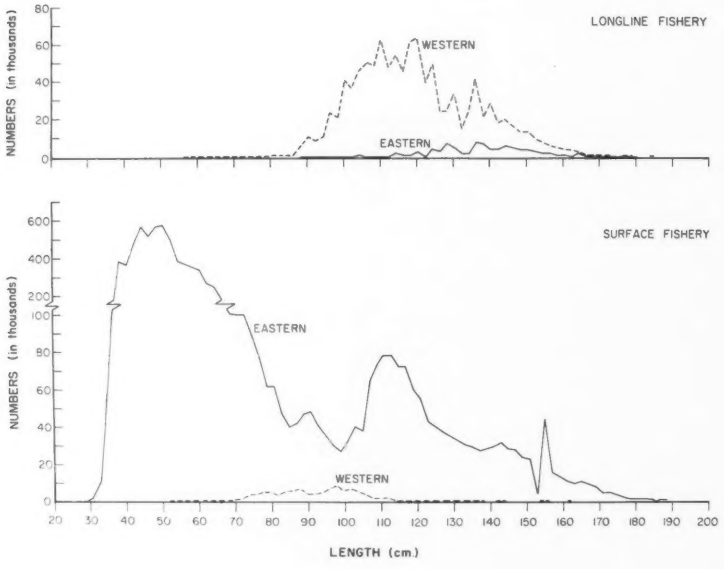
Figure 8.—Average fork length of yellowfin tuna caught in the longline fishery of the eastern and western Atlantic.



SURFACE FISHERY

Yellowfin and skipjack tunas are caught with surface gears in both the eastern and western Atlantic. The principal fishing areas are within 200 miles of the coast and currently most of the

Figure 9.—Estimated length composition of yellowfin tuna caught in the longline and surface fisheries of the Atlantic Ocean in 1974.



Atlantic catch is caught in the eastern Atlantic off Africa.

The eastern Atlantic surface fishery was an artisanal fishery up to about 1955. In that year, French baitboats from southern Europe moved into the Dakar, Senegal, region to fish for yellowfin tuna during November to May, when the boats were not employed in the albacore fishery off the Iberian peninsula (Champagnat, 1968). The boats were successful and baitboats of other countries soon entered the fishery. The fishery quickly expanded into southern waters and by 1960 the fleet was operating year-round from about Port Etienne, Spanish Sahara, to Pointe Noire, Zaire.

Purse seine fishing for tropical tunas, which was developed by U.S. Pacific coast tuna fishermen in 1956 (McNeely, 1961), was first tested in the Atlantic in the late 1950's. The technique was not seriously used in the Atlantic tropical tuna fishery, however, until 1961 by the French. Seiners of other countries soon thereafter entered the fishery. Currently more than 300 baitboats and purse seiners belonging to 12-15 countries participate annually in the eastern Atlantic fishery (ICCAT, 1976a). The largest fleet currently belongs to the combined French, Ivory Coast, and Senegal (FIS) countries.

Table 1.—Number of American tuna purse seiners[1] and their catches from the eastern tropical Atlantic, 1967-75.

Year	No. of vessels	Catch (t)		Catch rate (t/day's fishing)	
		Yellowfin tuna	Skipjack tuna	Yellowfin tuna	Skipjack tuna
1967	3	920	480	7.8	3.8
1968	8	5,830	3,180	23.3	12.0
1969	27	19,760	4,890	10.9	2.4
1970	25	9,810	11,790	4.0	5.1
1971	24	3,830	16,830	2.7	10.0
1972	36	12,100	12,250	3.3	3.7
1973	24	3,300	22,290	2.2	17.0
1974	26	5,620	19,970	2.8	8.7
1975	32	13,960	7,370	5.6	2.7

[1]The combined tropical tuna fleet of Canada, Netherlands Antilles, Panama, and the United States are monitored as a unit. "American" refers to this combined fleet which in 1968-75 consisted of at least 83 percent U.S. vessels.

Significant American participation in the Atlantic fishery began in 1967. In that year, three American tuna purse seiners fished off Africa and caught 1,450 metric tons of tuna in little over 2 months of fishing (Sakagawa and Lenarz, 1972). Their success attracted other American seiners into the fishery (Table 1). In 1975, 32 American tuna seiners participated in the eastern Atlantic fishery and their total catch was 13,960 metric tons of yellowfin tuna and 7,370 metric tons of skipjack tuna.

In the western Atlantic, the surface fishery for tropical tunas is small and not well developed. A few thousand metric tons are produced annually, principally by Cuban and Japanese baitboats, and French, Spanish, and American seiners. Cuban baitboats have fished primarily skipjack tuna in the Caribbean since 1932 (Suárez-Caabro and Duarte-Bello, 1961), whereas the other fleets are more recent participants and only occasionally fished in the western Atlantic for tropical tunas. American seiners of the tropical tuna fleet normally fish in the western Atlantic only while crossing the region enroute to Puerto Rico (to unload their catch) or fishing grounds in the eastern Atlantic and eastern Pacific. These vessels, therefore, do not spend many days searching for tunas in the western Atlantic. Because the surface fishery of the western Atlantic is small, this report does not attempt to fully discuss this fishery.

Species Mixture

Yellowfin and skipjack tunas are target species for the surface fishery. Yellowfin tuna, however, have traditionally been preferred by tropical tuna fishermen because it commands a higher market price. In fact, until recently some fishermen, particularly French fishermen, avoided the capture of skipjack tuna and caught them only incidentally with yellowfin tuna.

During the 1960's, when the catch rates of yellowfin tuna were high, an average of 56 percent of the total yellowfin-skipjack tuna surface catch from the eastern Atlantic was yellowfin tuna. As more units of fishing effort were applied to the fishery, the catch rates plummeted and the fishermen began relying more on skipjack tuna to fill their boats. The average percentage of yellowfin tuna in the catch declined to 42 percent during 1970-74.

Similar events occurred in the American catch (Table 1). Yellowfin tuna dominated the catch during 1967-69 and skipjack tuna during 1970-74. In 1975, however, skipjack tuna were

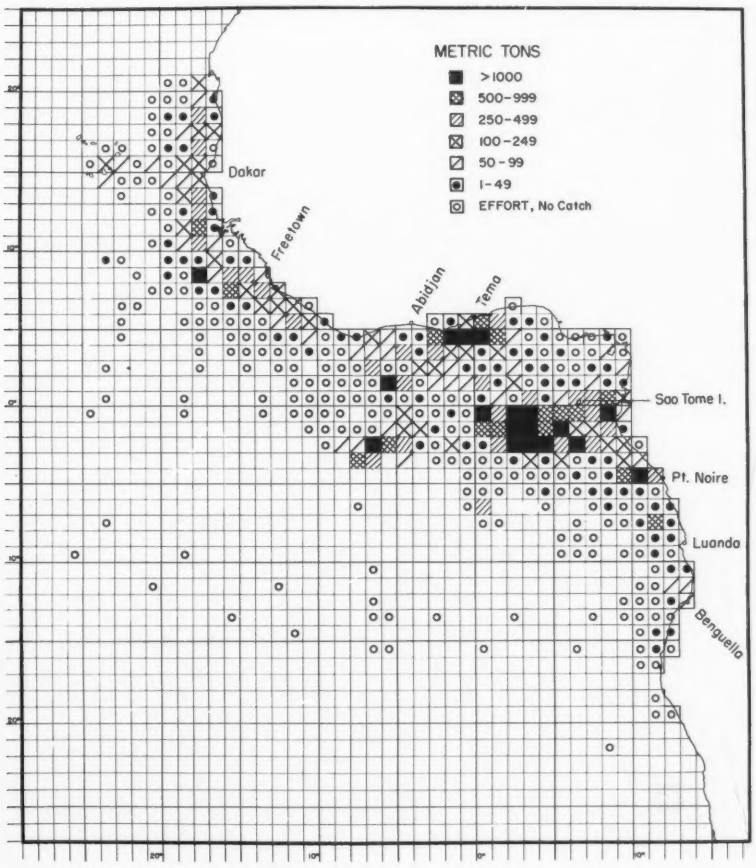


Figure 10.—Yellowfin tuna catch in 1° × 1° areas of the eastern tropical Atlantic. Logbook catches from the combined French, Ivory Coast, Senegalese, and American fleets for 1975 are shown.

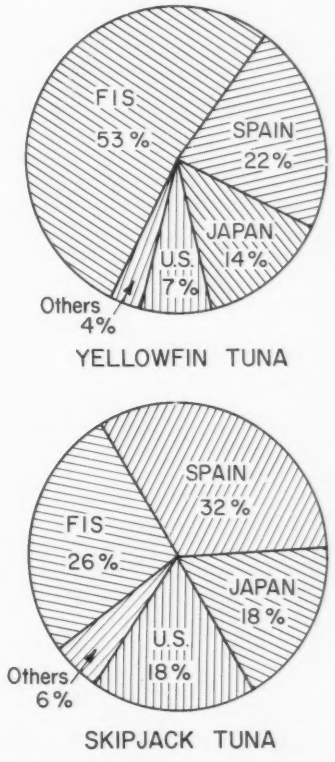


Figure 12.—Percentage of 1974 Atlantic catch of yellowfin tuna and skipjack tuna landed by major fleets. FIS fleet refers to French, Ivory Coast, and Senegalese boats.

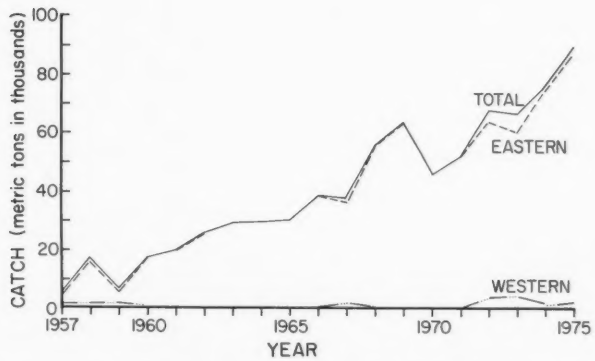


Figure 11.—Surface catches of yellowfin tuna from the eastern and western Atlantic, 1957-75.

scarce and American fishermen concentrated on catching yellowfin tuna. About 66 percent of that year's total catch was yellowfin tuna.

Yellowfin Tuna Catch and Catch Rates

The Atlantic surface catch of yellowfin tuna has fluctuated upwards at an average rate of 4,800 metric tons/year from 1957 to 1975 (Fig. 5). Since 1965 the catch has exceeded that of the longline fishery, and averaged 66 percent of the total Atlantic catch of yellowfin tuna.

Most of the Atlantic surface catch of yellowfin tuna is caught in the eastern Atlantic off Africa (Fig. 10). In 1975, about 99 percent of the catch was taken in the eastern Atlantic, primarily in the Gulf of Guinea (Fig. 11). About 96 percent of this catch was landed by the combined fleets of FIS, Spain, Japan, and the United States (Fig. 12).

Standardized catch rates for the eastern Atlantic fishery for yellowfin tuna

were estimated by Coan and Fox[3]. Their estimates for the surface fishery are based on data from the FIS fleet and for the series of years 1964-75 (Fig. 13). The series of estimated catch per standard day at sea (SDA) show a peak of 4.7 metric tons/SDA in 1968, and a low of 2.1 metric tons/SDA in 1973 and 1975. Two periods, one of high and the other of low catch rates are also evidenced in the time series (Fig. 13). The period of high catch rates was during 1964-69 when the rates averaged 3.6 metric tons/SDA. Lower catch rates, averaging 2.3 metric tons/SDA, occurring during 1970-75.

Similar periods can be identified in the nominal catch rates of the American fleet (Fig. 13). Catch rates were well above 6.0 metric tons/day's fishing during 1967-69 and less than 6.0 metric tons/day's fishing during 1970-75. In both of these periods the American catch was made primarily in the third and fourth quarters of the year, and the highest yellowfin tuna catch rates were in the Gulf of Guinea (Figs. 14, 15).

[3]Coan, A. L., and W. W. Fox. 1976. A production model analysis of the status of yellowfin tuna in the Atlantic Ocean, 1964-1975. NMFS, Southwest Fisheries Center, La Jolla, Calif., Admin. Rep. No. LJ-76-24, 16 p.

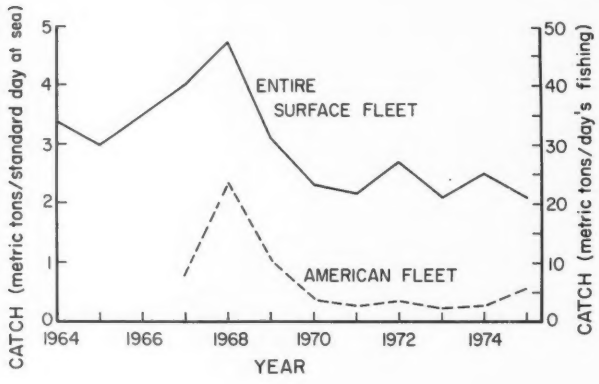


Figure 13.—Catch rates of yellowfin tuna caught in the surface fishery of the eastern Atlantic. Catch rates for the entire surface fleet (in metric tons/standard day at sea) and the American fleet (in metric tons/day's fishing) are shown.

Figure 14.—Average catch rates of yellowfin and skipjack tunas in 5° × 5° areas by quarter caught by American seiners in 1967-69.

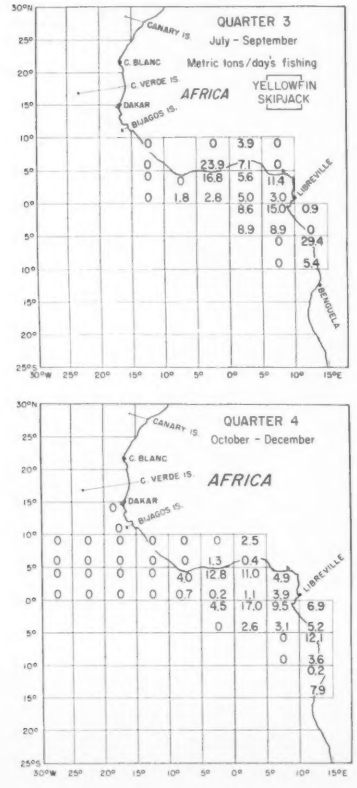
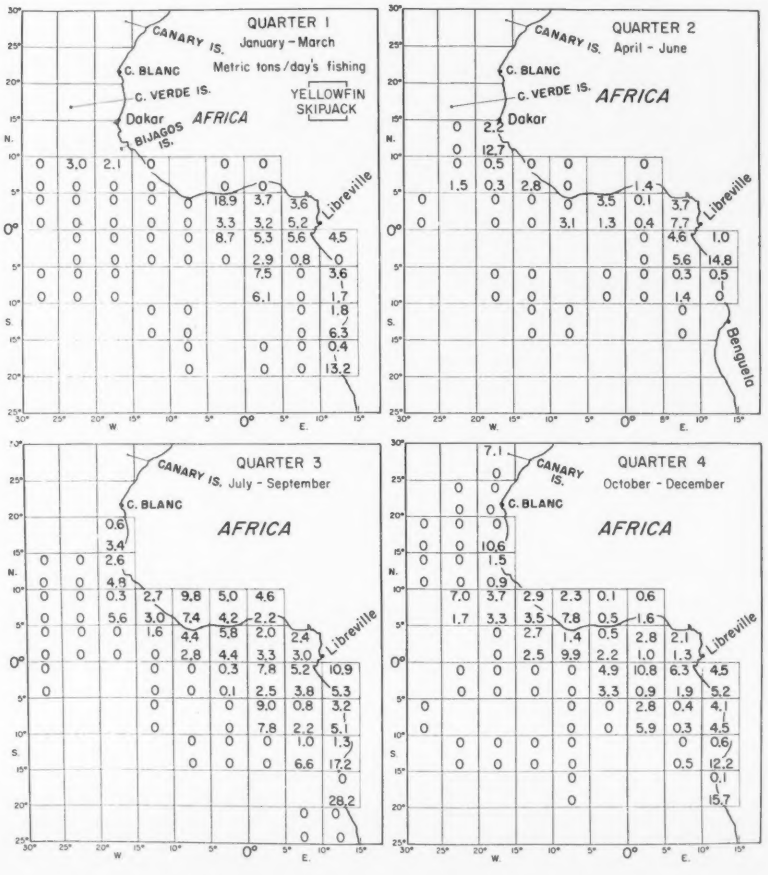


Figure 15.—Average catch rates of yellowfin and skipjack tunas in 5° × 5° areas by quarter caught by American seiners in 1970-75.



Yellowfin Tuna Size Composition

Size and age composition of yellowfin tuna in the surface catch of the eastern Atlantic was estimated by Coan[4]. His estimates show that fish between 31 and 125 cm long, or 1- and 2-year-olds made up the bulk of the catch in 1966-75. The dominant age group in most years was the 1-year-old (31 to 95 cm long—Fig. 9).

The average length of yellowfin tuna in the American catch ranged from 65 cm in 1971 to 111 cm in 1969 (Fig. 16). In all years except 1969, the dominant age group was the 1-year-old. In 1969 the dominant age group was the 2-year-old, probably resulting from the high percentage of catch from pure yellowfin tuna schools in that year (Sakagawa et al., 1976).

Skipjack Tuna Catch and Catch Rates

The catch of skipjack tuna from the Atlantic Ocean increased markedly between 1961 and 1975 (Fig. 17). The average rate of increase was about 10,000 metric tons/year with over 90 percent of the catch being taken in the eastern Atlantic. In 1975, the catch suddenly declined to approximately 59,500 metric tons from a peak in 1974 of about 114,700 metric tons. The cause of this sharp decline is believed to be due to poor availability, particularly off Angola in 1975.

Wide fluctuations in the catch have also been reported for other skipjack tuna fisheries, and they appear to be due to changes in availability and strength of year classes (Joseph and Calkins, 1969; Uchida, 1976). Oceanographic conditions are currently believed to be a major controlling mechanism for the fluctuations in availability of skipjack tuna (Williams, 1972).

Spanish, FIS, American, and Japanese tuna boats account for 94 percent of the total Atlantic catch of skipjack tuna (Fig. 12). Most of the catch is made in the Gulf of Guinea, off Senegal, and Angola (Fig. 18). In 1975, 70 percent of the total Atlantic catch of skipjack tuna was made in those areas.

Catch rates for skipjack tuna are

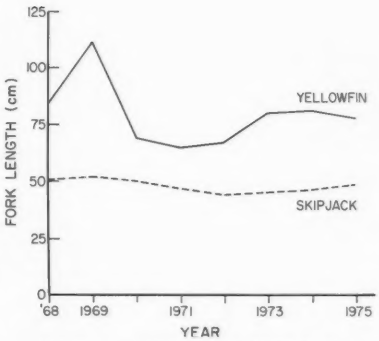


Figure 16.—Average fork length of yellowfin and skipjack tunas caught by American seiners in the eastern Atlantic.

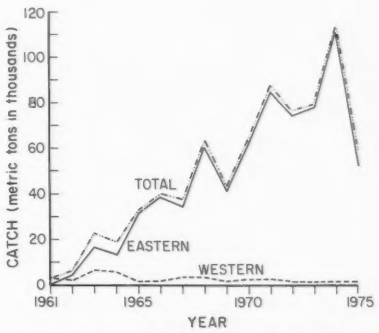
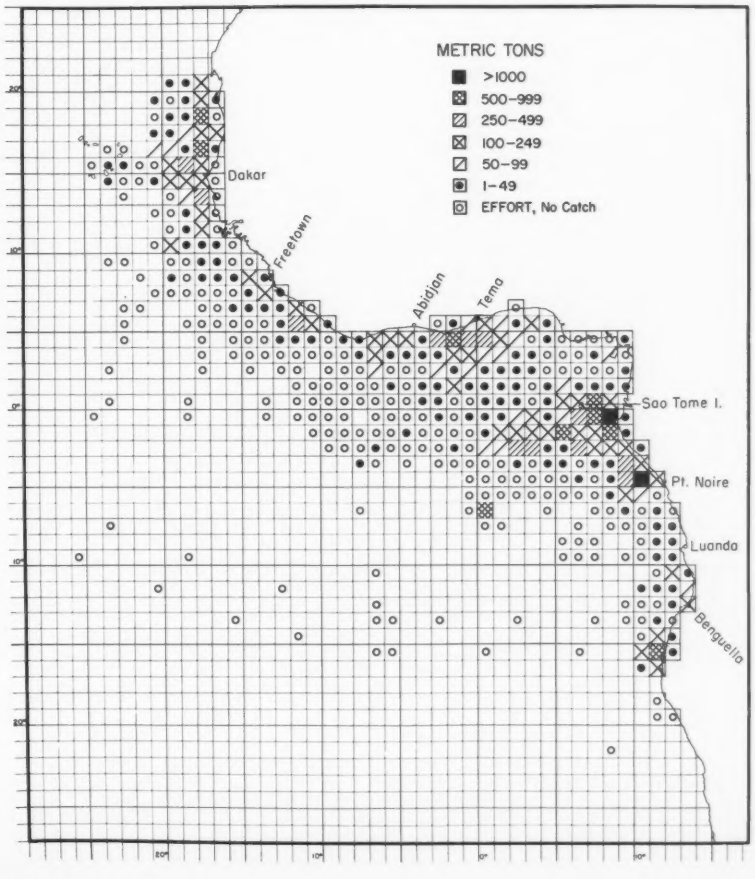


Figure 17.—Surface catches of skipjack tuna from the eastern and western Atlantic, 1961-75.

Figure 18.—Skipjack tuna catch in 1° × 1° areas of the eastern tropical Atlantic. Logbook catches from the combined French, Ivory Coast, Senegalese, and American fleets for 1975 are shown.



[4]Coan, A. L. 1976. Length and age composition of yellowfin tuna from the Atlantic Ocean, 1966-1975. NMFS, Southwest Fisheries Center, La Jolla, Calif., Admin. Rep. No. LJ-76-22, 23 p.

quite variable. They are affected by the fishing gear, time and area fished, and whether skipjack tuna and not yellowfin tuna is the principal target species. A representative catch rate for the fishery is therefore difficult to estimate. Sakagawa and Coan[5] calculated standardized catch rates for the skipjack tuna fishery based on stratified nominal catch rates by vessel type and month, and by assuming that catch rates in the central part (Annobon) of the Gulf of Guinea (Fig. 2) were representative for the entire eastern Atlantic. Their estimates (Fig. 19) range from 1.2 metric tons/standard day's fishing in 1967 to 3.0 metric tons/standard day's fishing in 1971 and show peaks in 1971 and 1974. The 1975 estimate is 1.2 metric tons/standard day's fishing, or 43 percent below the estimate for 1974. This decline is less than the 52 percent decrease observed in the catch (Fig. 17), indicating that the stocks were not fished as hard as the decline in catch suggests.

Skipjack tuna catch rates for the American fleet are quite variable, but the trends are generally similar to those noted for the standardized catch rates of Sakagawa and Coan (Fig. 19). Most of the American catch of skipjack tuna since 1970, however, was made off Angola rather than in the Annobon region. The catch rates off Angola were exceptionally high in the third and fourth quarters of the year when most fishing by the American fleet took place (Fig. 15). High catch rates were also recorded in the first and second quarters in the Gulf of Guinea and off Senegal, but they occurred during the year when not much fishing by the American fleet took place. Consequently, they are not considered too reliable as indices of abundance.

Skipjack Tuna
Size Composition

The Atlantic surface catch of skipjack tuna consists primarily of 30- to 60-cm long fish, or 1- and 2-year-olds

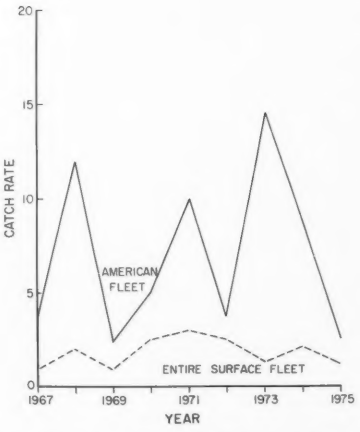


Figure 19.—Catch rate of skipjack tuna caught in the surface fishery of the eastern Atlantic. Catch rates for the entire surface fleet (in metric tons/standard day's fishing) and the American fleet (in metric tons/day's fishing) are shown.

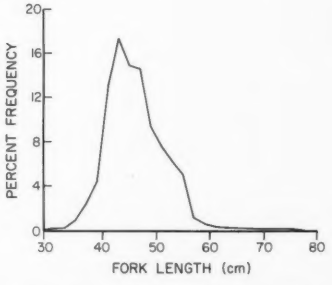


Figure 20.—Length frequency distribution of skipjack tuna caught in the eastern Atlantic in 1974.

(Fig. 20). For the past 5 years, 1-year-old fish (30 to 50 cm long) have dominated the catch, accounting for more than 50 percent of the numbers of skipjack tuna caught (Coan, 1976).

The American catch of skipjack tuna has likewise consisted of principally 1- and 2-year-old fish, with 1-year-olds dominating the catch (Sakagawa et al., 1976). The average length of fish in the American catch has fluctuated between a narrow range of 44-52 cm (Fig. 16).

STATE OF THE STOCKS

Production model analysis is commonly used in tuna stock assessments (e.g. Joseph, 1970; Skillman, 1975; ICCAT, 1976b). The analysis is usually based on catch-and-effort data from the fishery and relies on several assumptions, including: the model is applied to a closed, distinct, self-sustaining population; the concept of equilibrium conditions holds; and the age groups being fished remain constant. These assumptions rarely hold for tuna populations. Results from the analyses are consequently evaluated together with other information to determine the state of the stock.

Annual appraisals of the condition of Atlantic yellowfin and skipjack tuna stocks and fisheries are conducted by the Standing Committee on Research and Statistics of the International Commission for the Conservation of Atlantic Tunas (ICCAT). The appraisals have been based to a large extent on production model analysis.

Yellowfin Tuna

The most recent appraisal of the state of Atlantic yellowfin tuna stocks was made in 1976 (ICCAT[6]). The appraisal showed the stocks to be healthy and the catch increasing primarily because of offshore expansion of the surface fishery and strong recruitment of fish into the fishery. The maximum sustainable average yield (MSAY) was estimated to be 116,100 metric tons for the entire Atlantic fishery and 95,700 metric tons for the eastern Atlantic surface fishery only (Coan and Fox, footnote 3). These estimates were derived from a broad, flat-topped production model which indicate that only a negligible increase in equilibrium yield would result from further increases in fishing effort (Fig. 21). This conclusion has also been reached with yield per recruit models (Lenarz et al., 1974). The model also implies that at infinite fishing effort MSAY will be sustained from a reduced stock. This, of course, is impossible so conclusions drawn from extrapolation of the equilibrium yield curve too far to the right should be viewed with caution.

[5]Sakagawa, G. T., and A. L. Coan. 1976. State of the skipjack tuna stocks of the Atlantic Ocean from production model analysis, 1969-1975. NMFS, Southwest Fisheries Center, La Jolla, Calif., Admin. Rep. No. LJ-76-25, 14 p.

[6]ICCAT. 1977. Proceedings of the fourth regular meeting of the council (Provisional), November 17-22, 1976. Int. Comm. Conserv. Atl. Tunas, Madrid, Spain, 121 p.

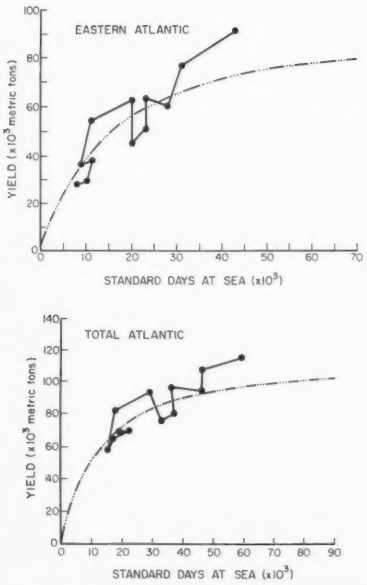


Figure 21.—Average yield curves and observed data, 1964-75, for the Atlantic fishery for yellowfin tuna.

A minimum size regulation is currently in effect for Atlantic yellowfin tuna that prohibits the taking of large numbers of fish less than 3.2 kg in size in excess of an incidental catch of 15 percent. The regulation was approved by ICCAT in 1972 to prevent reduction in the long-term yield through heavy exploitation of small fish. By 1974, most ICCAT countries had taken necessary legal action to implement the regulation. About 11,000 metric tons in 1974 and 4,000 metric tons in 1975 of undersized yellowfin tuna were caught by the eastern Atlantic surface fishery (ICCAT, footnote 6). The estimated losses to future yields from the removal of these undersized fish are approximately 10,000 and 4,000 metric tons. In other words, if the undersized fish were not caught in 1974 and 1975, they would have provided a total of 21,000 metric tons and 8,000 metric tons to the fishery in later years.

Skipjack Tuna

The catch of skipjack tuna from the Atlantic Ocean increased markedly during 1961-74, approaching crude estimates of potential skipjack tuna yields for the Atlantic (Sakagawa and Murphy, 1976). In 1975, however, fishermen experienced poor fishing for skipjack tuna and the catch reversed its upward trend, declining sharply by 47 percent. This was the largest decline recorded for the fishery and seemed to signal a decrease in stock abundance owing to fishing.

In 1976, ICCAT (footnote 6) reviewed the situation and concluded that the sharp decline in 1975 was due not to a decrease in stock abundance but to poor availability. It predicted that the catch would again be low in 1976 (about 40,000 to 50,000 metric tons) owing to fishing effort being diverted to catching yellowfin tuna.

Current estimates of MSAY for Atlantic skipjack tuna range from 89,300 to 118,400 metric tons for the eastern Atlantic surface fishery (Sakagawa and Coan, footnote 3). These estimates were derived from production models and are crude because satisfactory procedures to adjust the data to assumptions of the model have not yet been developed for Atlantic skipjack tuna. Nevertheless, the estimates indicate the general magnitude of the sustainable yield from the stock and that the yield can be quite variable because the fishery depends heavily on year classes that are available for only 1 or 2 years. Apparent natural mortality (biological and emigration), especially for fish older than 2 years, consequently, is high and there is no current need for instituting size or catch regulations for conservation purposes.

SUMMARY

The tropical tuna fishery is the largest tuna fishery in the Atlantic Ocean. In 1975, it produced approximately 174,000 metric tons of yellowfin and skipjack tunas.

The yellowfin tuna fishery is concentrated in the eastern tropical Atlantic. Growth of the fishery has been principally in the surface fishery since 1969, when the longline catch stabilized at about 30,000 metric tons. The stocks currently appear to be in good condition and capable of yielding larger catches but probably at a reduced catch-per-unit of effort.

The skipjack tuna fishery is also concentrated in the eastern tropical Atlantic. The catch reached a record high of 114,700 metric tons in 1974 then suddenly decreased to 59,500 metric tons in 1975. This decline apparently was due more to reduction in availability rather than reduction in abundance. The stocks currently appear to be in good condition. However, future catches can be expected to vary markedly, simply because skipjack tuna characteristically fluctuate widely in availability; the fishery is largely dependent on one or two year classes, which causes instability in production; and the amount of fishing effort exerted on skipjack tuna is dependent on availability and abundance of the co-target species, yellowfin tuna.

ACKNOWLEDGMENTS

Our sincere thanks to William H. Lenarz and David Kramer of the Southwest Fisheries Center for reading the manuscript and offering constructive criticisms. The paper has benefited from their keen eye for details and extensive knowledge of tuna fisheries. Any errors or lack of clarity in the paper, however, are solely the responsibility of the authors.

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MFR PAPER 1273

Synoptic Comparison of Three Sampling Techniques for Estimating Abundance and Distribution of Selected Megafauna: Submersible VS Camera Sled VS Otter Trawl

JOSEPH R. UZMANN, RICHARD A. COOPER, ROGER B. THEROUX, and ROLAND L. WIGLEY

INTRODUCTION

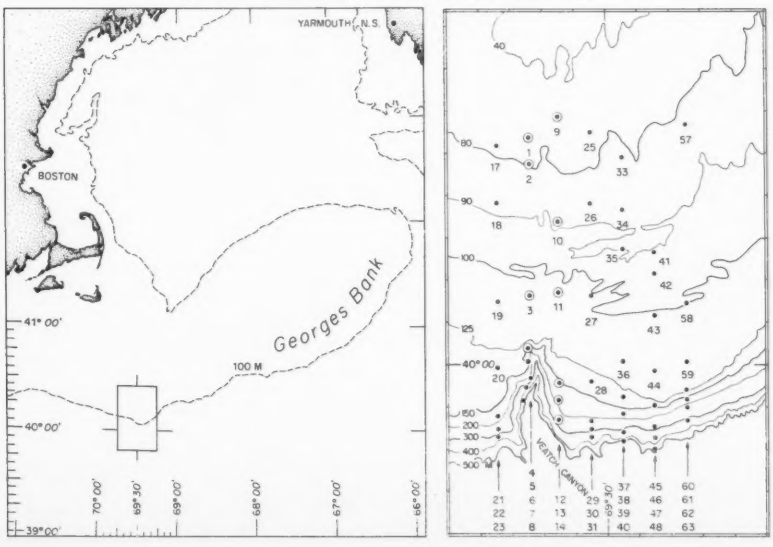
A multiship survey of the megafauna in the Veatch Canyon region (Fig. 1) was undertaken in June 1973. The survey was designed to obtain detailed information on the distribution, abundance, and ecology of selected megafauna, particularly lobsters, *Homarus americanus;* red crabs, *Geryon quinquedens;* and jonah crabs, *Cancer borealis;* and to compare simultaneously the relative efficiency of three bottom oriented quantitative survey techniques, namely, manned submersible, towed camera sled, and a standardized otter trawl. These primary techniques were reinforced by follow-up sampling with multiple pot trawls of standard baited lobster pots. The trapping studies were conducted in collaboration with the Prelude Lobster Co. of Westport, Mass.[1], from company vessels FV *Crystal S.* and FV *Mars;* these efforts provided valuable information on distribution and apparent relative abundance of lobsters and crabs, but quantitative comparison with the primary census methods is not possible because the seabed area from which the entrapped lobsters and crabs originated cannot be estimated. The trapping results will be treated in a separate report.

The Veatch Canyon area was chosen because of its background as the historical center of a commercially productive offshore lobster fishery (Schroeder, 1955, 1959; McRae, 1960; Hughes, 1963; Saila and Flowers, 1968; Skud and Perkins, 1969; Cooper and Uzmann, 1971; Uzmann et al., 1977). This fishery developed rapidly in the mid-1950's as a directed otter trawl fishery, gave way gradually to trap fishing methodology in the late 1960's, and began to decline in the early 1970's. Probable causes of declining production include overexploitation, inflationary overhead costs, and compounding of the latter by weather related gear losses, overruns, and loss of trap gear by otter trawl gear directed at lobsters and other target fish species.

In the face of this complex background, we hoped to obtain direct measures of lobster abundance from submersible and camera sled transects to compare with indirect assessments by otter trawl and trapping; within this framework we would thus compare availability and catchability while effecting intercalibration of the camera sled and trawl gear against assumed "ground truth" of submersible observations.

[1]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 1.—Veatch Canyon and sampling station array.



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Each of the primary survey techniques has readily evident advantages and disadvantages over the others in such terms as support vessel requirements, cost effectiveness, weather limitations, specialized manpower requirements, operational reliability, systems redundancy, and quantitative reliability of samples; this last characteristic was of primary interest to us because traditional assessments of benthic fishery resources, including megabenthic crustacea, are based largely on trawl net surveys of one kind or another. Despite the proven effectiveness of trawl gear for commercial harvesting of demersal fishes, lobsters, crabs, and shrimps, the absolute efficiency, hence sampling efficiency, of this gear is poorly understood with respect to any given target species, especially the lobsters and crabs of immediate interest. The operations reported here provided for the first time synoptic comparison of the three survey methods and produced a useful data base from which biological and operational inferences may be drawn.

METHODS AND MATERIALS

Sampling Design

Sampling stations were chosen according to a stratified random sampling design used at this laboratory for otter trawl assessment of demersal fish stocks (Grosslein, 1969). This scheme recognizes four ecological zones (southern New England, Georges Bank, Gulf of Maine, western Nova Scotia) within which four depth zones bounded by 30, 60, 100, and 200 fathoms are sampled randomly. Our specific study area (Fig. 1) was laid out as seven north-south transects ranging from 73 to 366 m (40-200 fathoms); the specific sampling sites chosen were selected randomly along these transects with the condition that adjacent stations be at least 1′ of latitude apart and that each of the three depth zones covered receive approximately equal attention. Of 63 stations originally designated for sampling efforts, only 51 were sampled in one way or another because of preoccupation of the remainder by commercial fishing activity.

Submersible operations were limited by time constraints to stations 1 to 6 and 9 to 14. Among these, stations 5 and 6 on the western slope of the head of Veatch Canyon were topographically unsuitable for camera sled and trawl operations. Thus the 10 stations 1 to 4 and 9 to 14 were used for quantitative comparisons. The sequence of station occupancy was: 1) submersible, 2) camera sled, 3) otter trawl, and 4) traps; at certain stations samples of the substrate and associated infauna were taken with a Dietz-Lafond grab and a Naturalist dredge; in these cases, the samples were taken after otter trawl sampling. Mean time between deployment of the submersible and otter trawl at given stations was 2.1 days (range 1-3 days). Specific strategies employed with each of the primary sampling techniques are given below with respective gear specifications.

Submersible System and Operations

The two-man submersible *Nekton Gamma* (Fig. 2) and support vessel *G. W. Pierce* were leased from General Oceanographics, Inc., Newport Beach, Calif. This submersible has the following published specifications (Shenton, 1972; General Oceanographics, Inc.[2]):

General

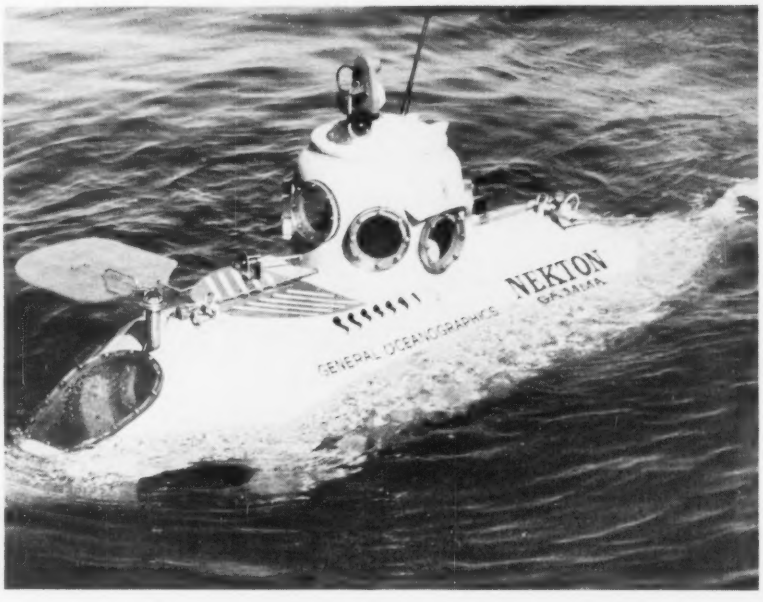
Crew (pilot and observer)	2
Pressure listed depth	1,500′
Certified operating depth	1,000′
Collapse depth	2,500′
Weight (pounds)	4,700
Payload (pounds)	450
Viewports	17
Length overall	15′6″
Height overall	6′0″
Pressure hull diam.	42″
Pressure hull length	96″

Systems

Propulsion —One 3.5 hp D.C. motor.
Power source—Lead acid batteries, 4.5 kwh.
Depth control—Bow plane, water ballast, drop weights.
Navigation—Magnetic compass, directional gyro, depth gauge; pinger, retractable marker buoy.

[2]General Oceanographics, Inc. Undated. Nekton submersibles. General Oceanographics, Inc., 2172 Dupont Drive, Newport Beach, CA 92664. 4 p.

Figure 2.—Research submersible *Nekton Gamma* maneuvering on surface.



Communication—Underwater telephone, CB radio.
Buoyancy—2 main ballast tanks, one auxiliary trim tank.
Life support—48 man hours.
Sampling—Mechanical arm (38″ reach), sample container.
Photographic—exterior strobe and tungsten lamps to support interior hand held cameras and video equipment.

Cruise speed and duration of *Nekton Gamma* is reportedly 1.5 knots for 3.5 hours or 2.5 knots for 1 hour. In our operations, we limited our transect runs over the bottom to 0.3-0.5 knots; at greater speeds, apparent relative motion precludes careful assessment of details and sufficient lead time for effective photographic or video pass shots of key subject material. Within a dive time budget of 3 hours, all transects were completed with adequate time for stopping, bottom sitting, or close maneuvering about a site for such tasks as substrate sampling, bottom current measurement, temperature recording, and carefully composed photographic or video documentation of faunal behavior and species interactions.

The preselected dive sites were located by Loran A navigation and marked with an anchored buoy having an 8.8-m (20-foot) above-water mast topped with a radar reflector screen. The submersible was launched from the mothership by a deck-mounted articulating crane and lowered into the water close to the marker buoy. Just prior to launch, a so-called tether ball or tracking float was secured to the submersible's conning tower by a 50-thread braided nylon line of sufficient length and scope to trail behind on the surface as the submersible cruised just off bottom; this line was payed out as the submersible gradually descended. The transect was begun when all line was payed out, the tether ball deployed and well clear of the support vessel, and the submersible reported itself ready on bottom. The support vessel maintained a position close behind the tether ball and monitored the submersible's course by taking periodic radar ranges and bearings on the anchored marker buoy. Course corrections and distance traversed were communicated to the submersible by acoustic telephone at appropriate intervals to effect two consecutive 0.5 nautical mile transects on headings which provided the most uniform depth at a given station. All dives were made during daylight hours between 0730 and 1750.

The dive plane of the submersible was rigged with a detachable wooden yardarm to which a 3-m (9.8-foot) length of 1-inch (25.4-mm) chain was secured 2.4 m (5.5 feet) from the longitudinal axis of the craft; when cruising just off bottom, the free end of the chain tended bottom and defined a sampling path width of 2.4 m from the keel centerline within which all fish and invertebrates could be readily seen, identified, and enumerated. All observations within this sampling path were recorded on audio tape for later collation and analysis. Faunal densities (number/acre) were estimated from the number of given organisms counted within the transect path divided by the calculated acreage; the averages of replicate values were used in subsequent analyses.

Two 150-watt tungsten filament lamps were directed forward and downward on both port and starboard sides of the vehicle; these lamps provided sufficient illumination on either side for direct viewing and for monochrome video documentation up to 6 m (19.6 feet) forward and laterally. Hand held 35 mm still camera photography was fully effective through the viewing ports to maximum operating depths with an externally mounted (starboard side only) and synchronized 150-watt-second stroboscopic flash unit. Selected examples of still photographs obtained on various dives are shown in Figures 3-6.

Camera Sled System and Operations

The second survey technique permitting direct visual assessment of the megabenthos was the Towed Underwater Benthic Sled (TUBS) which is depicted in operation in Figure 7 and with calibration screen in Figure 8. This sled-mounted photographic system is a prototype designed and constructed at this laboratory specifically for assessment of megabenthic invertebrates. To date, it has been used successfully on two major expeditions—the study reported here, and an extensive red crab survey in June-July 1974 (Wigley et al., 1975).

The system consists of a 70-mm (2.75-inches) camera and stroboscopic light source mounted on a large steel sled. Dimensions of the sled are: 2.7 m (9 feet) long, 2.1 m (7 feet) wide, and 1.9 m (6 feet, 8 inches) high. It is constructed of heavy gauge 6.4-cm (2.5-inch) diameter steel pipe with runners 25.4 cm (10 inches) broad and 2.5 cm (1 inch) thick. The sled weighs 1,225 kg (2,700 pounds) in air. The camera is a Hydro-Products Deep Sea Photographic Camera, Model PC-705; the strobe unit is a Hydro-Products Deep Sea Strobe, Model PF-730. The camera unit is mounted with the lens nodal point 1 m above the bottom and centrally located between the sled runners with a 45° forward angle of view. The camera utilizes a water contact 43.7 mm, *f*/2.8 Leitz fully corrected lens with a viewing angle of 65° in water. Camera and strobe were operated in a fully automatic mode taking pictures at 10-second intervals while underway. Kodak Tri-X Pan (black and white) film and Kodak Ektachrome EF daylight (color) film were used with comparably good results. Bottom area covered in photographs was 4.29 m^2 as determined from underwater test photographs of a 10-cm steel grid mounted equiplanar with the upper surface of the sled runners (Fig. 8).

The camera was towed slowly, 1.5 to 2.0 knots, by the NOAA research vessel RV *Delaware II*. Transects were made only at those stations where the topography of the sea floor was suitable; high relief areas and high angle slopes were avoided; suitability of the bottom was evaluated immediately prior to launch by means of fathometer tracings. Duration of the sled tows at each station ranged from 30 to 75 minutes depending on local conditions. Upon completion of the tow, the film was removed from the camera and a

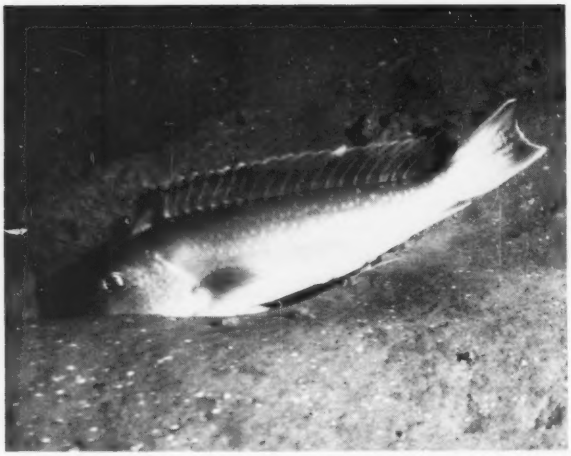


Figure 3.—Tilefish, *Lopholatilus chamaleonticeps,* about to enter burrow at base of low terrace on west flank of Veatch Canyon, depth 183 m (600′). From Ektachrome X 35 mm color transparency.

Figure 4.—Lobster, *Homarus americanus,* and black-bellied rosefish, *Helicolenus dactylopterus,* association in extensively burrowed clay outcrop on west flank of Veatch Canyon, depth 183 m (600′). From Ektachrome X 35 mm color transparency.

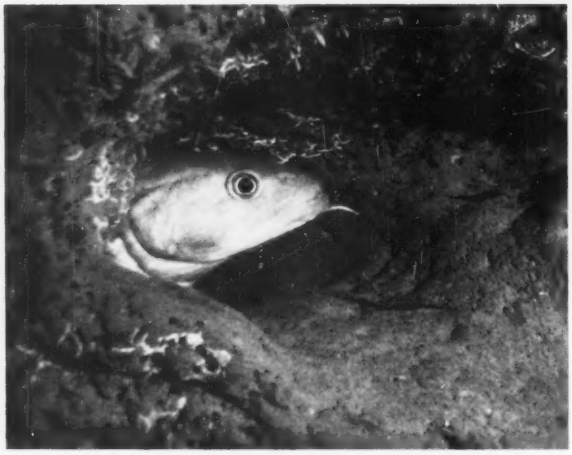


Figure 5.—Cusk, *Brosme brosme,* and lysmatid shrimp association in deep burrow on west wall of Veatch Canyon, depth 146 m (480′). From Ektachrome X 35 mm color transparency.

Figure 6.—Lobster, *Homarus americanus,* in characteristic excavation of level sandy silt substrates; west flank Veatch Canyon, 137 m (450′). From Ektachrome X 35 mm color transparency.

short strip developed to monitor focus, strobe light position, exposure, etc. The remainder of the film was subsequently shipped to commercial film processors for developing and printing. Selected examples of photographic results are shown in Figures 9-12.

For identification and enumeration of the megafauna recorded in the photographs, the transparencies (black and white negatives or color positives) were projected onto a large viewing screen on which was superimposed a proportionally calibrated metric grid of the seafloor area encompassed in the photographs. Faunal densities were estimated by summing the area covered by the series of transect photographs, dividing the total into the total count of each target species in the photographs, and adjusting the respective quotients to numbers per acre; density calculations from replicate tows were averaged for use in subsequent analyses.

Otter Trawl Configuration and Operations

Otter trawl operations were conducted from the R V *Delaware II* at 45 stations including 11 of the primary stations 1-14. The sampling gear was a roller rigged #41 shrimp trawl with a 36- to 38-foot spread (Fig. 13). Replicated half-hour tows at 3.5 knots were made at all stations occupied in common with submersible, camera sled,

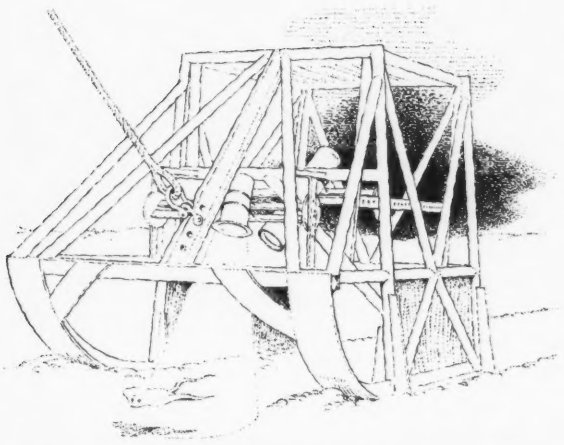


Figure 7.—Artist's rendition of Towed Underwater Benthic Sled (TUBS) photographic system in operation.

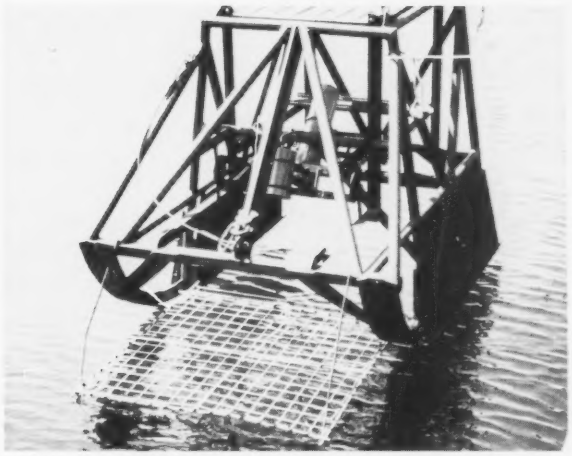


Figure 8.—TUBS being lowered into water for calibration test. Each square of calibration grid is 10 cm on a side; the grid is positioned in the plane of focus and covers slightly more than the area viewed by the lens.

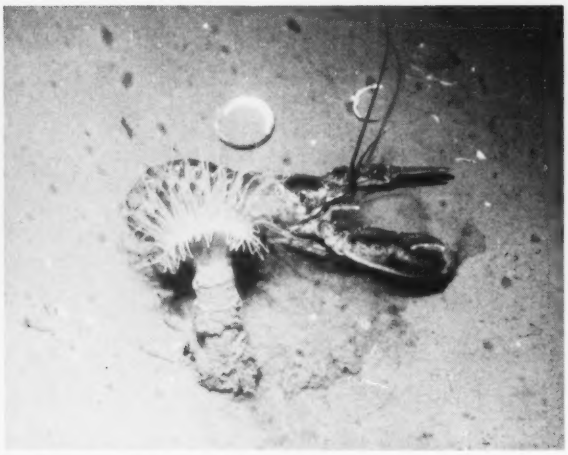


Figure 9.—American lobster, *Homarus americanus*, utilizing the ubiquitous burrowing anemone (*Cerianthus borealis*) as a haven. Also identifiable are two sand-filled valves of the ocean quahog, *Arctica islandica*, and above and to the right a partly buried starfish; at the base and to the left of the anemone are two shrimp. From Tri-X Pan 70 mm monochrome.

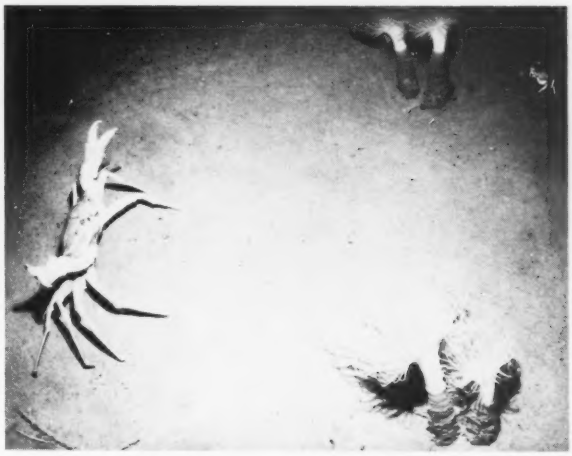


Figure 10.—Two of the target organisms; the deep sea red crab, *Geryon quinquedens*, and jonah crab, *Cancer borealis*, upper right, associated with four burrowing anemones (*Cerianthus borealis*). From 70 mm Ektachrome EF color transparency.

and trap trawls. Suitability of the bottom for trawling was determined, as with camera sled tows, from fathometer tracings of the prospective transect area. Depth and bottom temperature at the start of each tow were determined from an expendable bathythermograph cast prior to setting out the trawl.

Trawl catches were sorted and processed (identified, counted, and weighed) aboard ship; selected components of the catch were preserved and returned to the laboratory ashore for additional study. Size, weight, sex, and other biological information was recorded for individual lobsters, red crabs, and jonah crabs in each haul. Fish species taken in large numbers were weighed collectively to determine mean weight and sampled randomly to obtain mean length. Mean weights of various species obtained in trawl samples were used in calculations of biomass estimates from submersible and camera sled transects. Faunal densities were estimated from calculated acreage of trawl path divided into numbers of target organisms captured. Density calculations from replicate tows were averaged for use in tabular

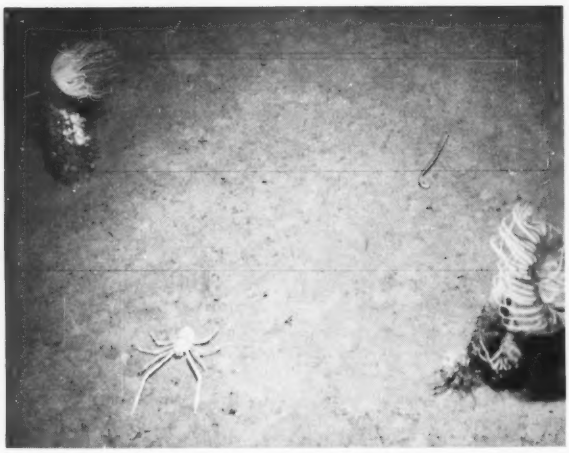


Figure 11.—The burrowing anemone (*Cerianthus borealis*) here harboring (upper left) a partially hidden galatheid crab, along with other small anemones on its tube and (lower right) another specimen with associated spider crab, small anemones, and worm tubes on its stalk; between the two large anemones are another galatheid crab and (upper right) a fawn cusk eel, *Lepophidium cervinum*. From 70 mm Ektachrome EF color transparency.

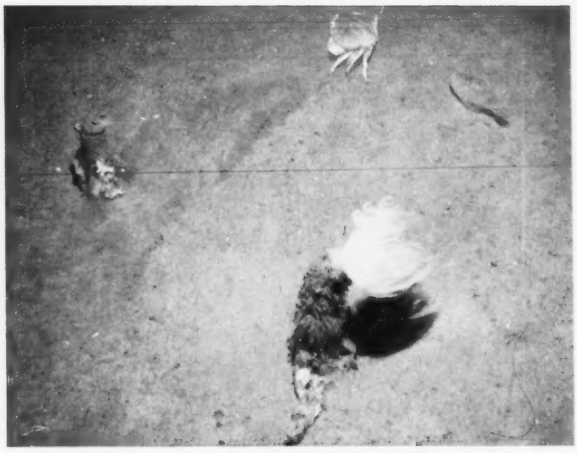


Figure 12.—Two burrowing anemones (*Cerianthus borealis*) (one retracted) and their associated attached fauna, *Cancer borealis* and a small unidentified flounder. From 70 mm Ektachrome EF color transparency.

and statistical comparisons of the three survey techniques.

RESULTS

A limited checklist of species or species groups documented by one or more of the three survey techniques is presented in Table 1; this list is limited to mobile species or species groups whose estimated density according to any one of the survey methods was equal to or greater than one individual per acre at any two of the 10 common stations. One particular finding of the overall survey was that red crabs did not occur shoaler than 150 fathoms (274.3 m); since all of the 10 common stations were shoaler, no comparison of gear efficiency can be made with respect to this species.

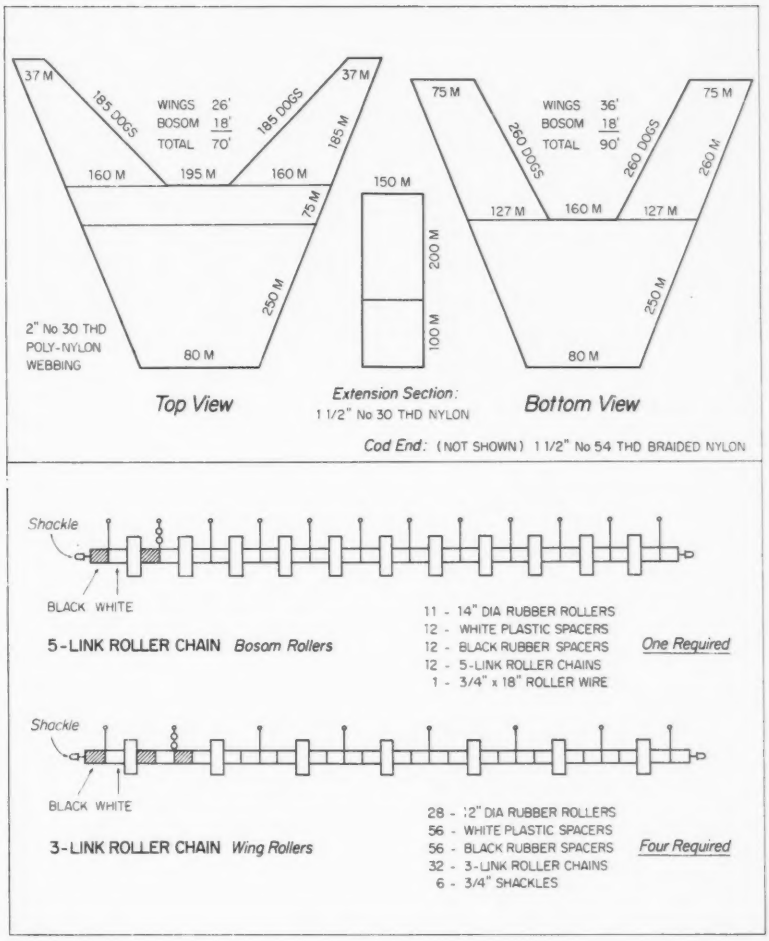
Table 1 provides the basis for subsequent comparison of species density estimates by gear. In order to minimize the likely bias of nonrandom distributions owing to such factors as schooling, aggregation on preferred substrates, temperature regime, depth, and the like, the species (or groups) selected for comparison were further limited to those which were documented from no less than five stations by each of at least two of the three methods; these qualified taxa, or groups, are ranked in order of decreasing abundance in Figure 14. Speciation of many forms such as shrimps, squids, hakes, flounders, and grenadiers was readily accomplished on direct examination of trawl catches, but similar diagnostic precision was not always possible from submersible sightings, or from the photographic negatives and positives; accordingly, we have pooled data on closely allied species to permit a maximum number of useful comparisons in Figure 14; density estimates were transformed as indicated to permit graphic comparisons of widely divergent values. The significance of differences between estimates by gear was examined by the Friedman two-way analysis of variance by ranks (Conover, 1971). While sampler variability, per se, and repeatability of results need be tested further before valid intercalibration terms can be inferred, we believe that the data, as analyzed, provide useful insights on the three methods.

While it was originally intended that all gear comparisons be made from daytime operations, the interactions with commercial fleet operations repeatedly forced the otter trawling schedule out of phase such that 8 of the 10 stations of common interest were occupied at night. The immediate result of this schedule alteration was to theoretically bias the catches of flounders and hakes upwards, and the catches of squids downwards (Bowman, 1974; Sissenwine and Bowman[3]). This inherent bias (i.e., overestimate) has been retained in the case of the hakes and flounders, but compensated in the case of the squids; thus squid abundance estimates as shown in Figure 14 have been expanded to theoretical daytime equivalents of Table 1 values by a factor of 18.9 (Sissenwine and Bowman, footnote 3) in order to reflect their significantly greater vulnerability to otter trawls under daytime conditions, the norm for submersible and camera sled operations.

Figure 14 shows that density estimates of the eight dominant faunal components varied widely according to assessment methodology; in general,

[3]Sissenwine, M. P., and E. W. Bowman. 1977. Relative fishing power of the Yankee No. 36 and modified Yankee No. 41 bottom trawls towed by the research vessels *Albatross IV* and *Belogorsk* during periods of light and dark. (Manuscript.)

Figure 13.—No. 41 roller-rigged shrimp trawl (70'-90').



the submersible technique yielded highest estimates followed by camera sled and trawl. Documentation of numbers of species or higher taxa (Table 1) was highest by submersible (30 taxa), followed by trawl (19 taxa), and camera sled (14 taxa). Density estimates derived by submersible were significantly higher in six of the eight comparisons with trawl-derived estimates; photo sled estimates were significantly higher than trawl estimates in five of the eight categories. Submersible counts were comparable with photosled counts in five categories, but significantly higher in three. Thus, results support the hypothesis that continuous visual assessment of the benthos provides the best approximation of species abundance and diversity.

Trawl-derived estimates of the 34 taxa listed in Table 1 were numerically superior in four cases, namely, squids, herring, mackerel, and butterfish; among these, the last three were documented only from the trawl survey. With squids occurring at all 10 stations, the four taxa occurred collectively at four stations, and in groups of two or three at four other stations. This qualitative and quantitative disparity between survey techniques is suggestive of photonegative response of these pelagic forms to the light sources common to the submersible and photo sled. Repeated studies using these diverse survey techniques should clarify this point and perhaps resolve the converse postulate that some taxa are attracted toward point sources of light and may be overcounted. It should be noted also that these four pelagic species are least constrained to the very bottom of the water column where camera sled and submersible are most effective and

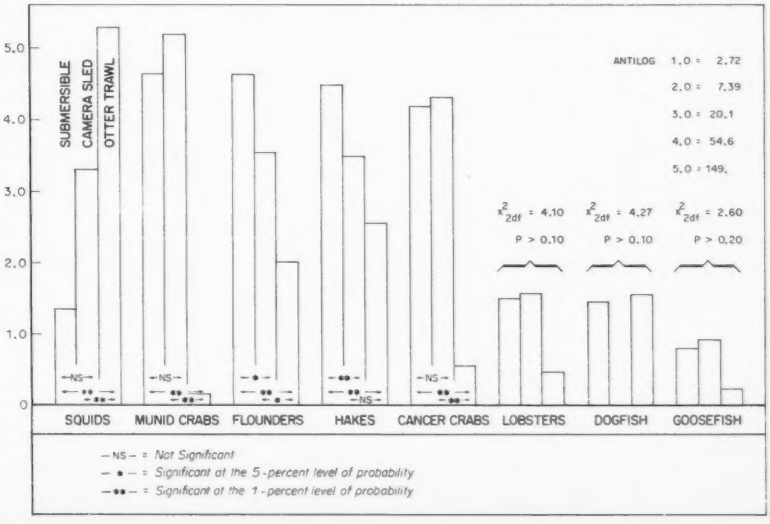


Figure 14.—Comparison of submersible, camera sled, and otter trawl in estimating abundance of dominant megafauna at 10 common stations (1-4, 9-14) in region of Veatch Canyon; Y-values are natural log $(X + 1)$ where X is estimated average abundance in numbers per acre from Table 1.

Table 1.—Estimates of standing crop of selected megafauna in numbers per acre at stations 1-4 and 9-14 as determined from surveys by submersible (S), camera sled (C), and otter trawl (T). Stations are arranged in order of increasing depth.

Species	STN 9			STN 1			STN 2			STN 10			STN 11			STN 3		
	S	C	T	S	C	T	S	C	T	S	C	T	S	C	T	S	C	T
American lobster	6.5	—	0.4	4.5	6.0	0.4	2.5	10.0	1.4	4.0	15.0	2.2	—	—	—	—	—	—
Cancer crabs	154.0	209.0	4.4	88.5	77.0	0.2	63.5	95.0	0.5	50.5	30.0	1.7	44.0	24.0	0.2	31.0	33.0	—
Munid crabs	—	9.0	—	—	—	—	—	—	—	—	—	—	144.5	24.0	—	273.5	54.0	—
Portunid crabs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6.5	—	—
Hermit crabs (shelless)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hermit crabs (shelled)	11.5	9.0	—	16.0	—	—	2.0	—	—	1.5	—	—	1.5	—	—	.5	—	—
Shrimps	5.5	—	—	9.5	—	—	—	—	—	9.5	—	—	5.0	—	—	13.5	—	—
Squids	—	—	6.3	—	—	1.6	—	—	1.4	1.5	—	5.3	1.5	—	9.9	1.0	—	2.4
Octopus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scallop	—	—	—	—	—	—	—	—	—	4.0	60.0	—	—	—	—	1.0	—	—
Brittlestar	—	—	—	—	—	—	—	—	—	—	—	—	24,265.0	—	—	—	—	—
Silver hake	14.0		3.8	6.5		8.0	15.5		29.9	5.0		5.7	16.5		—	16.5		8.6
Hakes (red and white)	135.5	[1]78.0	14.3	104.0	[1]33.0	0.7	44.5	[1]35.0	6.3	47.0	[1]30.0	6.5	44.0	[1]24.0	3.8	62.0	—	7.2
Goosefish	—	—	0.7	—	—	—	—	—	—	1.5	—	0.1	1.5	—	—	1.5	—	1.2
Sculpins	—	9.0	—	—	—	—	—	—	—	—	—	—	1.5	—	—	1.5	—	—
Cusk eel	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	67.0	0.2
Rosefish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11.5	—	—
Skates	1.5	—	0.3	5.0	—	—	—	—	—	—	—	0.3	—	—	—	—	3.0	—
Tilefish	—	—	—	—	—	—	—	—	—	1.5	—	—	—	—	—	—	—	—
Snake eel	14.0	—	—	10.5	—	—	5.0	—	—	9.0	—	—	25.5	—	—	2.5	—	—
Hagfish	—	—	—	—	—	—	—	—	—	—	—	—	1.5	—	—	—	—	—
Grenadiers	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Short bigeye	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dogfish	1.5	—	1.2	—	—	9.1	1.0	—	18.5	6.5	—	7.2	2.5	—	0.9	—	—	—
Ocean pout	4.0	—	0.1	3.0	—	0.1	0.5	—	0.2	—	—	—	—	—	—	—	—	—
Winter flounder	—		—	—		—	—		—	1.5		—	—		—	0.5		—
Sand dab	1.5		—	3.0		—	—		—	44.0		—	2.5		—	—		—
Witch flounder	1.5	[2]26.0	0.7	—	[2]11.0	—	—	—	0.1	—	[2]30.0	0.1	—	—	—	—	[2]26.5	—
Yellowtail flounder	—		—	—		—	—		—	—		—	—		—	0.5		—
Fourspot flounder	4.0		3.4	11.5		0.1	2.5		2.5	7.5		3.3	6.5		0.6	15.5		4.5
Gulf stream flounder	48.5		5.2	55.5		6.2	19.5		22.3	13.0		—	244.0		—	100.0		—
Herring	—	—	—	—	—	4.3	—	—	2.9	—	—	0.9	—	—	0.3	—	—	—
Mackerel	—	—	0.3	—	—	0.8	—	—	0.8	—	—	5.2	—	—	1.2	—	—	—
Butterfish	—	—	—	—	—	1.6	—	—	0.8	—	—	0.6	—	—	2.4	—	—	4.5

Species	STN 4			STN 12			STN 13			STN 14			Grand means		
	S	C	T	S	C	T	S	C	T	S	C	T	S	C	T
American lobster	9.0	—	0.6	2.5	—	0.6	1.5	5.0	0.1	4.0	—	0.5	3.5	3.6	0.6
Cancer crabs	37.5	60.0	—	42.0	42.0	0.2	54.5	26.0	0.5	27.0	76.0	0.7	59.3	67.2	0.8
Munid crabs	347.0	676.0	0.7	89.5	754.0	0.7	105.0	66.0	0.4	12.5	51.0	0.1	97.2	163.4	0.2
Portunid crabs	1.0	—	—	1.5	—	0.1	12.5	5.0	0.3	9.0	—	0.1	3.1	—	0.1
Hermit crabs (shelless)	>1,000.0	—	—	>1,000.0	—	—	>1,000.0	—	—	—	—	—	>1,000.0	—	—
Hermit crabs (shelled)	—	43.0	—	—	—	—	5.5	—	—	—	34.0	—	3.9	8.6	—
Shrimps	8.0	—	—	—	—	0.1	—	—	0.4	98.5	—	0.4	15.0	—	0.1
Squids	2.0	248.0	10.7	5.5	—	43.8	9.0	—	3.9	8.0	—	21.6	2.9	24.8	10.7
Octopus	3.5	—	—	—	—	—	3.0	—	—	—	—	—	0.7	—	—
Scallop	—	17.0	—	—	12.0	—	2,223.0	—	—	—	8.0	—	223.0	9.7	—
Brittlestar	—	2,849.0	—	28,310.0	18.0	—	—	10.0	—	—	—	—	>1,000.0	28.8	—
Silver hake	7.0		9.8	129.5		10.4	75.5		6.4	74.0		—	36.0		8.3
Hakes (red and white)	5.0	[1]17.0	1.3	—	—	1.3	6.5	[1]15.0	0.5	1.0	[1]68.0	0.2	45.0	[1]30.0	4.2
Goosefish	1.0	—	0.1	—	—	—	6.5	15.0	0.3	—	—	0.1	1.2	1.5	0.3
Sculpins	2.5	—	—	—	—	—	—	—	—	—	—	—	0.5	0.9	—
Cusk eel	—	120.0	—	—	—	0.1	—	—	0.1	—	—	—	—	18.7	—
Rosefish	55.0	—	—	—	—	0.1	1.5	—	—	15.5	—	2.1	8.4	—	0.2
Skates	—	—	—	—	—	—	—	—	—	—	—	—	0.7	0.3	0.1
Tilefish	1.0	—	—	—	—	—	—	—	—	—	—	—	0.3	—	—
Snake eel	17.0	—	—	21.5	—	—	43.0	—	—	1.0	—	—	14.9	—	—
Hagfish	3.5	—	—	—	—	—	10.5	—	—	19.0	—	—	3.5	—	—
Grenadiers	—	—	—	—	—	—	1.5	—	—	61.5	76.0	0.1	6.3	7.6	—
Short bigeye	—	—	—	1.5	—	—	43.0	—	—	—	—	—	4.4	—	—
Dogfish	—	—	—	20.5	—	—	—	—	—	—	—	—	3.2	—	3.7
Ocean pout	—	—	0.1	—	—	—	—	—	—	—	—	—	0.8	—	0.1
Winter flounder	—		—	—		—	2.5		—	—		—	0.5		—
Sand dab	—		—	2.5		—	—		—	—		—	5.4		—
Witch flounder	—	[2]180.0	—	10.0	[2]12.0	0.1	—	[2]10.0	0.4	2.5	[2]25.0	0.1	1.4	[2]32.0	0.2
Yellowtail flounder	2.5		—	9.0		—	—		—	—		—	1.2		—
Fourspot flounder	9.5		2.4	7.5		0.3	5.5		2.9	—		0.1	7.0		2.0
Gulf stream flounder	141.5		—	54.0		3.8	86.5		5.9	5.0		—	76.8		4.3
Herring	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.8
Mackerel	—	—	2.5	—	—	0.2	—	—	—	—	—	—	—	—	1.1
Butterfish	—	—	9.3	—	—	0.1	—	—	—	—	—	—	—	—	1.9

[1]All hakes combined.
[2]All flounders combined.

should, more likely, be more effectively sampled by the high opening trawl.

DISCUSSION

The relative merits of each of the three survey techniques must take into account a variety of practical and scientific considerations that tend to become highly subjective according to the users' experience (or inexperience) with each of the methods. It has become evident to us from this survey, and from prior and subsequent experience with each of the three methods operating independently, that apparent relative efficiency determined after the fact does not answer the practical question of which is the "method of choice" in a previously unstudied area. Those of us experienced in submersible surveys believe, cost considerations aside, that the overall advantages of direct visual assessment cannot be equalled by either of the other options taken singly. In certain situations such as rocky, precipitous bottom or submarine canyon heads and slopes, for example, there is no question that the submersible is the only effective survey strategy; conversely, over smooth bottoms, very adequate surveys can be made by photo sled at lowest cost per unit area surveyed and with fewest logistical problems.

Trawl surveys have the distinct advantage of providing not only qualitative and quantitative information on the population structure of an area, but also the inherent option of hands-on examination of catches for a great variety of other purposes within and beyond population assessment. This single advantage may, in certain kinds of surveys, outweight the evident sampling inefficiencies with respect to benthic invertebrates and bottom oriented fishes such as hakes and flounders. While it appears that bottom trawls, especially those that are roller rigged, tend to underestimate actual abundance of certain important species, this bias may also be present, to a lesser degree, with both submersible and photo sled. The distinct advantage of direct observation is that the reactions of species to the submersible can be observed and judgments made concerning the probable bias.

Further comparative studies such as this in areas with mutually amenable bottom topography should eventually provide a confident intercalibration of these methods on a species-by-species basis. The evidence at hand, nevertheless, suggests that any one method alone is unequal to the task of complete sampling efficiency.

The optimum strategy for detailed surveys of groundfish and benthic invertebrates may prove to be a combination of submersible or photo sled transects backed up with specialized trawl tows to provide specimen material for collateral studies (e.g., Wigley et al., 1975). The choice between photo sled or submersible will be dictated by cost, expected or known bottom topography, logistic capabilities of support vessel, and expected or known visibility conditions on bottom. In areas of consistent high turbidity, of course, photographic or visual assessment is virtually impossible; when such conditions prevail over untrawlable bottoms, a survey strategy will be limited to traps, gill nets, tangle-nets, line trawls, angling, or combinations of these labor intensive methods with the attendant difficulties of quantitative interpretation.

ACKNOWLEDGMENTS

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MFR PAPER 1274

The Sea-Run Cutthroat Trout Resource and Sport Fishery

PERCY WASHINGTON

INTRODUCTION

No doubt, the cutthroat trout, *Salmo clarki,* was well represented in the creel of the first angler/settler in the Pacific Northwest. The sea-run cutthroat is available to anglers through most of the year—either in fresh water or in marine estuaries (commonly called "salt-chuck" by Pacific Northwest anglers). The written record of the fishery is sketchy. However, the cutthroat or "harvest trout" season is about as much of a traditional fishery as can be found anywhere. Harvest trout is a local name for modest sized trout that return during the late summer and fall months in sizable schools, coinciding roughly with crop harvests.

Puget Sound angler proudly displays a fine sea-run cutthroat trout. (Photo courtesy of the *Seattle Times.*)

Cutthroat trout, while not attracting the attention that the larger chinook salmon, *Oncorhynchus tshawytscha;* coho salmon, *O. kisutch;* and steelhead trout, *S. gairdneri;* do, is probably the third most popular marine gamefish in the Pacific Northwest, behind coho and chinook, since steelhead are primarily caught in rivers. In Oregon's coastal rivers and estuaries, cutthroat trout are highly prized and heavily fished by anglers using techniques varying from fly casting to worms. In Washington, anglers also use a wide variety of techniques, but a greater amount of secrecy (compared with Oregon anglers) surrounds many of their activities.

LIFE HISTORY AND STATUS OF POPULATION

The sea-run (anadromous) cutthroat trout is found from northern California (DeWitt, 1954) to Prince William Sound, Alaska, in most fresh waters with access to the sea, in estuaries and bays, and in coastal waters. As with other anadromous salmonids—i.e. salmon, trout, and char—the sea-run cutthroat usually returns to its river of origin to spawn (Gieger, 1972).

In the spawning act, the mature female digs a redd in gravel with her tail and deposits eggs, which are immediately fertilized by attendant male(s). After each spawning act, the female covers the eggs as she moves upstream and digs another redd, pushing gravel back over the original redd, providing a redd for the next group of extruded eggs. The eggs incubate in the gravel for a period, dependent on water temperature. Upon hatching, the light-sensitive larvae move further down into the gravel to complete development. With the completion of yolk sac absorption, the "fry" emerge and commence feeding on various small aquatic life forms.

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Table 1.—Age and number of previous spawnings of sea-run cutthroat trout taken at Sand Creek, Oreg., 1946-49 (Sumner, 1962).

Age in years	Number of annuli on scale		Number of previous spawnings			No. of fish	Percent of total	Fork length (mm)[1]
	Freshwater	Ocean	1	2	3			
2	1	1	—	—	—	1	0.26	(404)
3	2	1	—	—	—	11	2.93	323
4	2	2	12	—	—	12	3.19	386
	3	1	—	—	—	111	29.53	328
5	2	3	—	1	—	1	0.26	(417)
	3	2	50	—	—	52	13.85	373
	4	1	—	—	—	106	28.20	333
6	3	3	—	11	—	11	2.93	411
	4	2	35	—	—	36	9.58	368
	5	1	—	—	—	24	6.38	335
7	4	3	—	4	—	4	1.06	422
	5	2	3	—	—	3	0.79	373
	6	1	—	—	—	1	0.26	(343)
8	5	3	—	1	—	1	0.26	(409)
9	5	4	—	—	1	1	0.26	(422)
10	6	4	—	—	1	1	0.26	(429)
Total			100	17	2	376	100.0	
Percent of total			26.6	4.5	0.5	—	31.6	

[1]Average fork length is listed for each age group that has two or more fish.

Table 2.—Age-length relations of seaward migrant cutthroat trout taken at Petersburg Creek, Alaska, 1971 (Jones, 1972).

Fork length (mm)	Age (no. of annuli on scale)[1]					% of total
	3	4	5	6	Total	
141-160	1	—	—	—	1	4.8
161-180	—	—	—	—	0	0.0
181-200	1	—	—	—	1	4.8
201-220	—	1	1	—	2	9.5
221-240	—	4	3	—	7	33.3
241-260	—	1	1	—	2	9.5
261-280	—	—	5	1	6	28.6
281-300	—	—	1	—	1	4.8
301-320	—	—	—	1	1	4.8
Total	2	6	11	2	21	—
Percent of total	9.5	28.6	52.4	9.5	—	100.0
Avg. length (mm)	169	233	253	284	—	—

[1]Includes annuli formed at sea as well as in freshwater.

Table 3.—Age-length relations of the spawning migration of sea-run cutthroat trout taken at Petersburg Creek, Alaska, 1971 (Jones, 1972).

Fork length (mm)	Age (no. of annuli on scale)[1]							Percent of total
	3	4	5	6	7	8	Total	
141-160	1	—	—	—	—	—	1	1.3
161-180	3	1	—	—	—	—	4	5.3
181-200	2	5	—	—	—	—	7	9.2
201-220	3	6	—	—	—	—	9	11.8
221-240	—	6	2	—	—	—	8	10.5
241-260	—	9	1	—	—	—	10	13.2
261-280	—	6	4	—	—	—	10	13.2
281-300	—	1	2	—	—	—	3	3.9
301-320	—	—	6	2	—	1	9	11.8
321-340	—	1	3	1	1	—	6	7.9
341-360	—	1	1	—	—	1	3	3.9
361-380	—	—	—	3	—	—	3	3.9
381-400	—	—	1	—	1	—	2	2.6
401-420	—	—	—	—	1	—	1	1.3
Total	9	36	20	6	3	2	76	—
Percent of total	11.8	47.4	26.4	7.9	3.9	2.6	—	100
Avg. length (mm)	187	242	289	342	365	318	—	—

[1]Includes annuli formed at sea as well as in freshwater.

The sea-run cutthroat spends the first years of its life in fresh water, migrating then to inshore marine areas, usually near the home stream (Gieger, 1972). At maturity (normally no earlier than age 2 for males and age 3 for females), the fish ascend their stream of origin to spawn. A high percentage of cutthroat trout are multiple spawners. The freshwater and marine life histories of cutthroat trout vary within and among populations (Armstrong, 1971; Gieger, 1972; Jones, 1972; and Sumner, 1962) and seem directly related to growth rates of individuals. Presented in Tables 1-4 is information on age and growth of Oregon and Alaskan fish; life history data elsewhere in the sea-run cutthroat's range are sparse or lacking.

The sea-run cutthroat trout numbers only a small fraction of most of the other anadromous salmonids of the Pacific Northwest and is on a downward trend. Compared with Pacific salmon and steelhead trout, relatively little has been done to increase the cutthroat trout population through artificial propagation. However, major concentrations still exist in areas where human population pressures have not affected habitat or given rise to overharvesting of natural stocks.

Figures on the total catch of sea-run cutthroat trout and on fishing effort by anglers have not been published. While some studies and creel censuses have been made, data are fragmented and

Table 4.—Age-length relations of seaward migrant cutthroat trout taken at Eva Lake, Alaska, May and June 1964 (Armstrong, 1971).

Fork length (mm)[1]	Age (no. of annuli on scale)[1]									Percent of total
	3	4	5	6	7	8	9	10	Total	
121-140	1	—	1	—	—	—	—	—	2	1.0
141-160	—	—	—	—	—	—	—	—	0	0.0
161-180	—	1	—	—	—	—	—	—	1	0.5
181-200	2	6	—	—	—	—	—	—	8	4.1
201-220	—	8	3	1	—	—	—	—	12	6.1
221-240	1	5	8	2	—	—	—	—	16	8.2
241-260	—	4	16	4	—	—	—	—	24	12.3
261-280	—	—	5	5	7	1	—	—	18	9.2
281-300	—	—	1	10	17	1	—	—	29	14.8
301-320	—	—	2	16	12	1	—	1	32	16.3
321-340	—	—	—	11	15	—	—	1	27	13.8
341-360	—	—	—	7	4	2	1	—	14	7.1
361-380	—	—	—	3	3	3	—	—	9	4.6
381-400	—	—	—	—	2	2	—	—	4	2.0
Total	4	24	36	59	60	10	1	2	196	100.0
Percent of total	2.0	12.2	18.4	30.1	30.6	5.1	0.5	1.0	—	99.0
Fork length[2]	185	216	247	306	307	345	352	319	—	—

[1]Includes annuli formed at sea as well as in freshwater.
[2]Average fork length is listed for each age group that has two or more fish.

A father and son show off their prize. Sea-run cutthroat trout like this one produce thousands of hours of angling pleasure in the Pacific Northwest. (Photo courtesy of the *Seattle Times*.)

sketchy because records of the catch of sea-run cutthroat trout are not kept by fishery agencies, as is the case with steelhead trout and Pacific salmon.

ANGLING TECHNIQUES

At some place or another, there's a sea-run cutthroat trout waiting to take a fly or a lure at any time of the year. From late summer through winter, cutthroat generally can be found in some freshwater system. After spawning in winter, the sea-run cutthroat trout return to estuaries in spring, where they are available from the spring through the fall months.

A variety of approaches are successfully employed to capture sea-run cutthroat trout (Johnson, 1971). Included are trolling, fly casting, bait casting, and "spinning" (spin casting) from skiffs and shore in rivers, lakes, ponds, and inshore waters. Fly fishermen employ a wide variety of wet flies, which are generally attractor patterns—large and gaudy in color. Flies tied on size 4-10 hooks are most common, with colors like "hot" orange, bright reds, and yellows. Favored materials are dyed polar bear hair and bucktail wings with bright chenille or tinsel bodies. Hundreds of patterns have been developed and popular cutthroat trout fly patterns are listed here (Johnson, 1971).

Fly	Sizes
Black/gnat bucktail	4-12
Cutthroat bucktail	4-8
Pink shrimp	4-6
Conway special	4-8
Spruce fly	4-8
Kalama special	4-10
Knudsen's spider	4-10
Grayhackle-yellow	4-12
Muddler minnow	4-12
	(X or 4X long)
Grayhackle-peacock	4-16
McGinty	6
Silver demon	6-8
Silver spruce	6-8
Skagit minnow	6-8
Royal coachman bucktail	6-10

Lures for cutthroat fall into a few basic groupings which include spoons, spinners, plugs, and bobbers; these are presented with casting, spinning, or fly rods and reels.

An unlimited assortment of baits exists. Most popular are salmon eggs and worms; however, everything from grasshoppers to Pacific sand lance, *Ammodytes hexapterus*, are cutthroat trout food items and can be presented with casting, spinning, or fly equipment.

Strategies and tactics vary with setting in sea-run cutthroat trout fishing. There are as many ways to fish cutthroat trout as there are places to find them. Certainly casting lures or flies to cruising schools of cutthroat trout in fresh or salt water is one of the more popular and productive methods. Generally, as long as the angler can maintain contact with a school, the bite is on. This strategy is executed from a boat or the shore. In large bodies of waters when fish are scattered, trolling is a popular method of locating them. While some anglers prefer a line of spinners (or "pop" gear) placed in front of a bait or lure, just trolling a fly or a small plug will often attract the sea-run cutthroat trout. Another method involves drift fishing—wading or by skiff.

Cutthroat trout seem to have definite preferences in terms of habitat. In rivers they like backwaters, sloughs, and slow water with plenty of adequate cover (log jams, foliage overhangs, etc.).

In marine waters, they feed in shallow estuaries, over gravel beaches, and in or near "saltchucks" during high tide periods.

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Shortfin Squid, *Illex illecebrosus*, Attacks on Trawl-Captured Fish

SALVATORE A. TESTAVERDE

During the months July through November 1976, Gloucester, Mass., draggermen reported (pers. commun.) increasingly large catches of shortfin squid, *Illex illecebrosus*, from the Gulf of Maine and Massachusetts Bay to Georges Bank.

In a normal year, catch rates per 2-hour tow average about 25-35 kg; in 1976 the average catch per tow ranged from 400 to 500 kg with reports of some catches exceeding 5,000 kg.

CATCHES

Fishermen also reported that commercial size catches of fish were not usually taken when large concentrations of shortfin squid were captured. Furthermore, hauls that included mixtures of shortfin squid and fish were found to contain fish damaged by squid bites (Fig. 1). Those fish were rendered unsalable.

The majority of squid bites were located on the mid-body region, between the pectoral fins and the anus. Wounds ranged from 2 to 4 cm in diameter. In some cases, two or more wounds were found adjacent to each other, although it is not known if they were caused by the same squid. No squids were bitten.

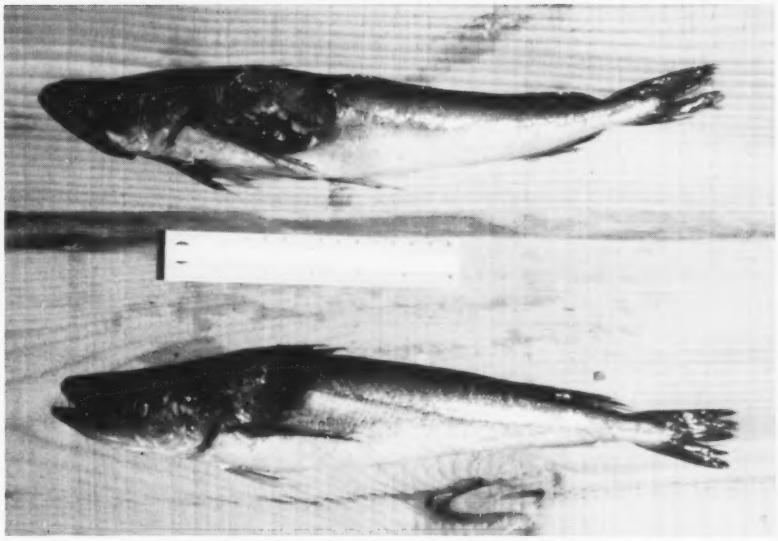

Figure 1.—Silver hake, *Merluccius bilinearis*, with wounds inflicted by shortfin squid, *Illex illecebrosus*.

Sizes of squid were reported to range from 20 to 30 cm, mantle length.

ACKNOWLEDGMENTS

I thank the crew of the fishing vessel *Linda B.*, of Gloucester, Mass., for bringing this to my attention and especially to Joseph Testaverde for the photograph.

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Foreign Fishing Vessels off U.S. Coasts Decrease to 492 in August

The number of foreign fishing and fishing support vessels sighted off U.S. coasts in August, 492, decreased dramatically from the year's high of 786 sighted in July, according to preliminary figures released by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, a Commerce Department agency.

The 492 vessels sighted are also below the 543 sighted off our coasts in August of 1976. The decrease is attributed to a reduction in the number of foreign vessels permitted to fish within the 200-mile zone and the normal seasonal decline in fishing activities.

The foreign vessels, from 11 nations, were sighted off the coasts of New England and the mid-Atlantic States, Gulf of Mexico, West Coast, and Alaska. The largest number, 352, was from Japan, which had 338 vessels fishing for salmon and pollock off Alaska, 11 fishing for squid off New England and mid-Atlantic, 2 longline vessels fishing for tuna in the Gulf of Mexico, and 1 fishing in the Western Pacific.

The Soviet Union had 66 vessels: 47 fishing for hake off the Pacific Coast, 12 fishing for squid off New England and mid-Atlantic, and 7 catching pollock in Alaskan waters. Canada, fishing under a reciprocal agreement with the United States, had four vessels fishing for salmon off the West Coast.

Foreign vessels sighted off the coasts in 1976 were as follows: January - 420, February - 510, March - 435, April - 560, May - 924, June - 970, July - 842, August - 543, September - 514, October - 452, November - 258, December - 240. In 1977: January - 319, February - 314, March - 180, April - 235, May - 374, June - 767, July - 786, and August - 492.

The August sightings were made by representatives of the National Marine Fisheries Service and by personnel of the U.S. Coast Guard, conducting joint fisheries enforcement patrols from Coast Guard aircraft and cutters.

A summary of foreign fishing vessels operating off U.S. coasts during August 1977 and August 1976 follows:

		No. of vessels	
Area	Nation	Aug. 1977	Aug. 1976
New England and mid-Atlantic	E. Germany	19	12
	Soviet Union	12	12
	Poland	2	3
	W. Germany	6	8
	Spain	21	3
	Japan	11	2
	Italy	3	6
	South Korea	0	3
	Greece	0	1
		74	50
Gulf of Mexico	Japan	2	4
	Cuba	0	43
		2	47
West Coast	Panama	0	4
	Japan	1	2
	Soviet Union	47	67
	South Korea	0	10
	Bulgaria	0	3
	Poland	6	9
	E. Germany	0	6
	Canada	4	[1]0
	France	1	0
		59	101
Alaska	Canada	0	[1]0
	Japan	338	219
	South Korea	10	56
	Taiwan	2	4
	Soviet Union	7	66
		357	345
	Total	492	543

[1]Number of Canadian vessels off U.S. shores not recorded.

FOREIGN HERRING QUOTA UNCHANGED

Foreign fishermen catching herring off the northeast coast in early September were permitted to take the full 21,000 metric tons quota originally established by the Secretary of Commerce, according to the National Marine Fisheries Service.

That announcement followed an order by the U.S. District Court in Portland, Me., dismissing a suit brought by the State of Maine against Secretary Juanita M. Kreps. The Court found that herring stocks in the area were not jeopardized because of foreign fishing, and that the preliminary fishery management plan approved by the Secretary permitted an adequate growth rate for the depleted stock, while allowing enough herring to meet the catch capabilities of U.S. fishermen. The foreign fishing season permitted under the plan ran from 15 August to 30 September.

While preliminary management plans may not, by law, impose a catch quota on U.S. fishermen, the plan in effect estimated that the U.S. fleet would take 12,000 metric tons of herring this year off Georges Bank and southern New England—far greater than U.S. landings in past years. The foreign fishing quota was established based on this estimated catch by U.S. fishermen, and on an optimum yield of 33,000 metric tons. The 33,000 metric ton catch level was expected to let the number of herring in the waters increase by 10-13 percent in 1977.

The Court also found that the Secretary's determinations of optimum yield, the capacity of the U.S. herring fleet, and the total allowable level of foreign fishing were in full accord with the Fishery Conservation and Management Act of 1976, the "200-mile" fishing law.

Marine Pollution Study Contracts Let by NOAA

Potential problems which may result from the transport of oil along the coasts of Alaska and Washington states and from deep ocean mining in the tropical Pacific Ocean are the subjects of more than $600,000 in research contracts awarded to the University of Washington, Seattle, by the National Oceanic and Atmospheric Administration.

The contracts, awarded by the Commerce Department, agency's Environmental Research Laboratories in Boulder, Colo., include $200,000 let to the Zoology Department, $378,698 to the Oceanography Department, $56,500 to the Fisheries Research Institute, $27,032 to the Division of Marine Resources, and $20,500 to the Applied Physics Laboratory. They were announced by Commerce Secretary Juanita M. Kreps.

Marine research conducted by the Zoology Department and the Fisheries Research Institute is part of an intensive study of northern Puget Sound to determine the probable impact of increasing oil shipment and refining activities there. The study is funded by the U.S. Environmental Protection Agency, and managed by NOAA's Marine Ecosystems Analysis (MESA) program.

Principal objective of the continuing research is to document marine life inhabiting the northwest Washington tidal regions adjacent to the Strait of Juan de Fuca now to enable scientists to assess the environmental effects of a potential oil spill.

Results of the research will be compared with data the university has collected from the San Juan Archipelago, a group of islands northwest of the Strait in the San Juan Island-Cherry Point-Anacortes oil refining area, under a separate contract with the Washington State Department of Ecology.

The Applied Physics Laboratory and the Oceanography Department at the university will conduct research to help determine the potential effects of deep sea mining on the marine environment as part of NOAA's Deep Ocean Mining Environmental Study (DOMES), a MESA project conducted by NOAA's Pacific Marine Environmental Laboratory in Seattle, Wash.

Supplemental funds have been given to the university's Division of Marine Resources for its Arctic Dynamics Joint Experiment to conduct additional research on the interaction of oil with sea ice in the Beaufort Sea on the northern coast of Alaska. Additional funds were awarded to the Oceanography Department to continue study on Bristol Bay oceanographic processes and begin a new study of the Norton Sound-Chukchi Sea oceanographic processes.

The contract is part of a major environmental study conducted by NOAA for the Interior Department's Bureau of Land Management as part of its Outer Continental Shelf Environmental Assessment Program. These studies seek to determine the probable ecological impacts of oil exploration and development activities on Alaska's outer continental shelf.

In addition, contracts totaling $132,067 have been awarded to firms in Massachusetts and Maryland for research on the effects of oil spills on marine environments. The awards were made to the Marine Biological Laboratory of Woods Hole, Mass.; Energy Resources Company, Inc.,[1] of Cambridge, Mass.; and ARCTEC, Inc., of Columbia, Md. The contracts were also let by the agency's Environmental Research Laboratories.

The Woods Hole firm will do biological studies of the effects of two oil spills on Cape Cod environments—the Argo Merchant and Buzzards Bay oil spills. Energy Resources will conduct field sampling services, extraction processes, and gas chromatograph analysis of sediment samples from the Buzzards Bay area, located between the mainland and the southern portion of Cape Cod peninsula.

ARCTEC will make research studies of both the Buzzards Bay and Hudson River oil spills which occurred on 28 January and 4 February 1977. This contract work is also part of a major marine environmental study conducted by NOAA's Environmental Research Laboratories for the Interior Department's Bureau of Land Management as part of its Outer Continental Shelf Environmental Assessment Program. These studies seek to determine the probable ecological impacts of oil exploration and development activities on Alaska's outer continental shelf. John Robinson, project manager for the hazardous materials response group of NOAA's Marine Ecosystems Analysis program office, will be monitoring the contract work for all three firms.

Federal, State Agencies Study Hawaiian Sea Life

Under a cooperative agreement for the survey and assessment of living resources of the little known Northwestern Hawaiian Islands area, researchers from the Commerce Department's National Marine Fisheries Service, the Interior Department's U.S. Fish and Wildlife Service, and the state of Hawaii's Division of Fish and Game visited each of the islands and worked in adjacent waters from 4 July through 17 August. NOAA ship *Townsend Cromwell,* home-ported in Honolulu, provided the work platform.

The 5-year study will provide a detailed survey and assessment of the biological resources upon which to base management decisions about long-range use and preservation of the living resources of the area.

While the three agencies have overlapping scientific interests and, to some extent, jurisdictional authority as well, each has specific areas of interest. The National Marine Fisheries Service focuses on fishery resources occupying bottom and slope areas, and the open water or pelagic areas adjacent to the islands. The Hawaii Division of Fish and Game is primarily concerned with fishery resources from the shoreline out

[1] Mention of trade names of commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

to the beginning of the deepwater slope areas. The U.S. Fish and Wildlife Service, which manages the extensive Hawaiian and Pacific Islands National Wildlife Refuge, is interested in the area's seabirds and mammals. In addition, it shares the responsibility for management of sea turtles and the Hawaiian monk seal with NMFS.

Large numbers of tunas were spotted in 30-100 fathoms of water adjacent to the islands, according to NMFS fishery biologist Robert A. Skillman, who served as field party chief during the cruise and is overall coordinator of the study. The most abundant of the tunas were kawakawa, which resemble the local skipjack tuna, or aku. Where kawakawa around Oahu average about 5 pounds, the fish located farther to the northwest commonly weighed 15-20 pounds. Yellowfin tuna, or ahi, weighing about 10 pounds, were also present, as were wahoo, or ono. Almost 1,000 of these fish were tagged and released by NMFS in order to study their migration patterns.

The Hawaii Division of Fish and Game recorded over 150 species of fishes in the reef and inshore areas. Some are not found in the main Hawaiian Islands and a few have not been identified. The larger atolls harbored moi, aholehole, mullet, manini, and the baitfish piha in abundance, while ulua and large schools of papio were found throughout the Northwestern Hawaiian Islands.

Sharks were plentiful everywhere. Tiger sharks up to 12 or 13 feet in length were occasionally observed in knee-deep water. In addition to a collection of scientific information on fishes, algae, and corals, the State agency brought back samples of 57 species of fish for further study.

Green sea turtles and the endangered Hawaiian monk seal were surveyed on all the islands by Fish and Wildlife Service personnel. Of particular interest was the presence of seals at Nihoa and Necker Islands and at Maro Reef. Maro is a remote coral reef with only a small rock protruding above the ocean surface.

Information collected on these mammals will supplement that obtained earlier this year in an extensive NMFS-FWS monk seal survey. Fish and Wildlife Service scientists also recorded information on the endangered endemic birds of the island chain and on the several million seabirds that nest and feed there.

Fish Accumulate Benzene, Toluene—Water-Soluble Components of Crude Oil—After Brief Contact

There may be far-reaching consequences for estuarine and near-shore fishes constantly exposed to low levels of oil in inshore areas. The effects are not as immediately evident as those caused by more short-lived, catastrophic events such as tanker spills or marine oil-well blowouts, but in the long run they may prove to be more dangerous to marine populations.

Of particular concern to scientists studying the effects of constant oil exposure on ocean organisms are the prevalent components of petroleum and petroleum-related products that are both water-soluble, and toxic to fish. Two such components are the volatile aromatics, benzene and toluene, the most prevalent components in the water soluble fraction (Anderson et al., 1974). They probably exist at very low concentrations in areas subject to chronic oil exposure where few actual measurements have been made. If fish accumulate such aromatics, even at the assumed low levels, and if they must use additional energy to metabolize, detoxify, and depurate these substances, long-term physiological damage may result.

A recent study (Korn et al., 1977) was made by scientists of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), to determine which of these prevalent aromatics, benzene or toluene, poses the greater threat to marine life. It was hypothesized that toluene, although it is less soluble in seawater than benzene (Anderson et al., 1974), may be more toxic and exhibit greater accumulation levels and persistence. To test this theory, Sid Korn, Nina Hirsch, and Jeannette Struhsaker of NOAA's National Marine Fisheries Service, working at the Tiburon Laboratory, Southwest Fisheries Center, in California, compared the uptake, distribution, and depuration of benzene and toluene by fish at sublethal concentrations. A radioactive tracer technique was used in these studies. The radioactive isotope, carbon-14 (^{14}C), was combined with the chemically similar oil components, allowing the amount of benzene or toluene present to be determined by scintillation counting.

Pacific herring were selected as test animals because they are important as estuarine and nearshore forage fish for many important recreational and commercial species, including striped bass and chinook salmon.

Live herring were obtained from a San Francisco Bay bait dealer and transported to the Tiburon Laboratory dock. After a period of acclimation, the fish were exposed to low-level concentrations (100 parts ber billion) of either ^{14}C benzene or ^{14}C toluene for 48 hours. Gall bladder, intestine, pyloric caeca (first part of the small intestine), gill, brain, liver, muscle, kidney, and immature male and female gonad tissues were sampled for radiometric analysis after 6 hours of exposure, and then each day for 7 days.

All herring tissues had higher levels of toluene than of benzene. Certain trends were common to both aromatic components. The tissue with the highest accumulation was the gall bladder. Its benzene level was 31 times the initial water concentration, and its toluene level was 340 times the initial water concentration. The immature gonads had the lowest level of maximum accumulation. Pyloric caeca and intestine had varying amounts of bile, producing a range of ^{14}C activity and a resulting wide variation in calculated concentrations.

Most tissues rapidly reached

maximum accumulation levels; within 24 hours, all tissues except the gall bladder and pyloric caeca had maximum residues. Before benzene had peaked, toluene was at the maximum level in all tissues except the gall bladder and intestine.

Residues were depurated rapidly; most tissues had nondetectable amounts after 3-4 days (1-2 days after termination of exposure). However, the gall bladder, intestine, and pyloric caeca retained residues through the duration of the study (7 days).

Since accumulation levels in the gall bladder were based solely on radiometric analysis of the ^{14}C present and could include metabolites of the aromatics as well as unchanged benzene or toluene, an additional study was made to interpret the residue. After herring had been exposed for 2 days, the gall bladders were removed, weighed, and extracted. The extracts were analyzed for benzene and toluene by gas chromatography. No detectable benzene was measured. This indicated that most or all of the radioactivity measured in the gall bladders of fish exposed to benzene is not the parent compound, but one or more metabolites. Fish exposed to toluene had only a small amount of the parent compound. This result and the delayed depuration in the gall bladder, intestine, and pyloric caeca support the contention that benzene and toluene are metabolized in the liver, stored in the gall bladder, passed into the intestine, and excreted with the feces.

The results of this study are generally consistent with previous work by the same investigators (Korn et al., 1976) exposing striped bass and northern anchovy to ^{14}C benzene at the same concentration (100 parts per billion) and exposure period (48 hours), except for the considerably higher accumulation in the anchovy than in the other species. This is probably a result of the higher stress, activity level, and scale and mucus loss in the anchovy while in captivity.

The herring gonads sampled in this study were immature and had low accumulation levels. In another study where mature spawning herring were exposed to benzene (Struhsaker, 1977), the accumulation was higher in the ovary, with associated deleterious effects on the ripe ovarian eggs and on development of larvae. Immature herring appear less sensitive to exposures than mature herring in spawning condition.

Of the two components, toluene appears to be potentially a greater problem to fish. Toluene can be rapidly accumulated to high levels after even a brief contact during an oil spill. Since toluene is one of the more prevalent water-soluble oil components, further research on the effects and uptake of this component are indicated. Also, chronic exposures are probably more important to the survival of fish populations than are spills, and studies of long-term exposure to chronic concentrations should be made. Finally, the probability that benzene and toluene are rapidly metabolized or converted to metabolites (possibly phenol, which is also highly toxic) points up a need for metabolite research.

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P. K. Park Heads NOAA Ocean Dumping Program

P. Kilho Park, an oceanographer and expert on the chemical aspects of the marine environment, has been appointed manager of the National Oceanic and Atmospheric Administration's Ocean Dumping Program. As manager of the new program in NOAA's National Ocean Survey, Park will study industrial waste sites in the Gulf of Mexico, off Puerto Rico, and off the Atlantic seaboard adjacent to the New York Bight where NOAA is currently studying the ecological impacts of oceanic pollution. His office is at NOS headquarters in Rockville, Md.

Formerly with the Commerce Department agency's Environmental Research Laboratories in Boulder, Colo., Park was head of the National Science Foundation's Oceanography Section in 1970-71. He previously had been program director for physical and chemical oceanography at the Foundation in 1969-70.

Born in 1931 in Kobe, Japan, Park holds a B.S. degree in fisheries from the Fisheries College in Pusan, Korea. In 1957, he received an M.S. in Oceanography from Texas A&M, and a Ph.D. from the same university in 1961. He became a U.S. citizen in 1968. From 1961 to 1976, Park was a faculty member at Oregon State University where he became professor of oceanography in 1971. Park is a member of numerous professional societies including the American Geophysical Union, the Geochemical Society, and the International Association of Geochemistry and Cosmochemistry.

Coast Energy Impact Program Wins First Construction Grant

Award of a $798,618 grant to the State of Louisiana—the first construction grant to be made under the Coastal Energy Impact Program—has been announced by Secretary of Commerce Juanita M. Kreps. The grant, from the National Oceanic and Atmospheric Administration (NOAA) through its Office of Coastal Zone Management, will provide a critically needed water supply facility on Grand Isle in Jefferson Parish.

"Grand Isle is both an extremely appealing recreational spot and an important base for energy production," said Robert W. Knecht, Director of NOAA's Office of Coastal Zone Management. "The islands's water supply is adequate to handle the town's permanent residents, but cannot meet the increased recreational demand because of

the coastal energy activity. This situation is one that the Coastal Energy Impact Program was designed to alleviate."

Grand Isle is the base for several oil companies' operations and also attracts visitors, fishermen, campers, and beachgoers by the thousands during weekends and in the summer. South of Louisiana's marshlands and near Barataria Bay, it is one of the few places in the state where surf bathing can be enjoyed throughout the year.

Site of much of the recreational activity is a 100-acre state park visited by 380,000 persons in 1976. Frequently during the year, the park had to be closed because of a water shortage, and the Louisiana Department of Public Works has postponed construction of two additional bath houses there because of insufficient water supply.

The new water system will provide an adequate water supply for present and anticipated needs, and will enable full recreational facilities to be restored. Under the grant, land will be acquired, a million gallon ground storage tank erected, and pumping, piping, and chlorinating facilities installed.

The Coastal Energy Impact Program was created by 1976 amendments to the Coastal Zone Management Act of 1972. Its purpose is to help states and communities plan for, and deal with, the effects in the coastal zone of coastal energy development. It includes credit assistance, planning grants, environment grants, and formula grants. First allotments of funds to coastal states under the program were announced by Secretary Kreps on 18 May.

Ohio Slated for First Freshwater Sanctuary

A grant for $894,152 to the Ohio Department of Natural Resources, to acquire lands near Huron, Ohio, for the nation's first freshwater estuarine sanctuary, has been awarded by the National Oceanic and Atmospheric Administration (NOAA), Secretary of Commerce Juanita M. Kreps has announced. The grant follows nearly 2 years of public review and comment upon the desirability of creating an estuarine sanctuary along Old Woman Creek, a 647-acre river and wetlands area near Huron.

Following land acquisition, the area would be designated a national estuarine sanctuary under provisions of the Coastal Zone Management Act of 1972. One sanctuary, marine, already exists, at Sapello Island, Ga.; and land is being acquired for two others, at Coos Bay, Oreg., and in Hawaii.

The purpose of the estuarine sanctuary program is to preserve unspoiled lands and waters for scientific research and public appreciation. The program is administered by NOAA's Office of Coastal Zone Management. NOAA is part of the Commerce Department.

According to Ohio officials, the state intends to construct a visitors' center along a highway bordering the planned sanctuary. Laboratory facilities will be made available to students and university researchers. Emphasis will be given to public education, as well, in view of the sanctuary's proximity to Cleveland and Toledo.

Although in a heavily populated area of the state, the land making up the sanctuary has been kept relatively unspoiled by efforts of adjacent property owners. Under the Coastal Zone Management Act, the Secretary of Commerce is authorized to provide funds for up to 50 percent of the cost of acquisition, development, and operation of estuarine sanctuaries as natural field laboratories.

Oceanic Education Gets NOAA Support

A program to develop materials for use in marine education for students in the fourth through eighth grades in North Carolina has received a $31,000 Sea Grant from the National Oceanic and Atmospheric Administration. The project, which will be augmented by $15,500 in non-Federal matching funds, is one of two educational projects announced by Ned A. Ostenso, Director of the National Sea Grant Program. The other program, to be carried out at the University of Maine under a $19,801 grant from the Commerce Department agency, will develop curriculum materials that concentrate on the coastal problems and resources in Northern New England. That grant will be supported by $12,333 in non-Federal matching funds.

The North Carolina program, which is expected to run over a 3-year period, also is designed to train middle school teachers in marine education through special 4-week summer courses covering a number of educational disciplines. The course, entitled "Man and the Seacoast—Past and Present," will consist of lectures, seminars, and field trips. The program will include presentations and educational materials on the coastal aspects of marine science, anthropology, history, literature, sociology, engineering, economics, and resource planning.

There are more than 500,000 children and 16,000 teachers in North Carolina's middle schools. These students and teachers are distributed in 145 school systems. North Carolina Sea Grant officials estimate that through the acceptance of 30 teachers a year in the program, training could be provided to teachers in 90 of those 145 systems in a 3-year period.

At the University of Maine, the major thrust of the project will be to adapt an educational program developed through the Delaware Sea Grant College Program to the problems and resources of northern New England. The program in Maine, which also will include in-service training of teachers, will be geared to students from kindergarten through the twelfth grade.

Marine "Costs" of Deep Sea Mining Monitored

The first operational tests of systems for gathering manganese nodules from the floor of the ocean began late in 1977 in the central Pacific Ocean, with scientists from the National Oceanic and Atmospheric Administration (NOAA) measuring the"cost" to the marine environment of deep sea mining.

Four international mining consortia plan systems tests over the next several years, according to the Commerce Department agency's Environmental Research Laboratories. The first to field its gear will be Deepsea Ventures, the operational arm of Ocean Mining Associates. Its activities will be monitored by NOAA scientists involved in the agency's Deep Ocean Mining Environmental Study (DOMES), using scientific instrumentation on the NOAA research ship *Oceanographer*. DOMES scientists also will be aboard the two Deepsea Ventures mining ships.

The dual efforts—the mining tests and the environmental study—represent for both industry and science the second step in harvesting the roundish lumps of rock containing high concentrations of iron, manganese, copper, and nickel. While industry has been working to develop techniques for collecting this wealth, DOMES researchers have been engaged in baseline studies of the state of the waters, life forms, and sea bed, prior to mining. These studies have focused on three sites in the central Pacific judged representative of the range of environmental regimes that mining might affect.

The tests NOAA scientists are to monitor will be of hydraulic systems for mining the nodules. A collector, or dredgehead, will travel along the sea floor, drawing in water, nodules, and whatever else lies in its path. The system will separate the nodules from other material, discharging much of the latter near the sea floor while pumping the nodules upward through a pipe to a ship. The remainder of the excess material will be discharged at the sea surface.

Over a 20-day period the scientists will concentrate on the effluent discharged at the surface. Researchers aboard the mining ships will note how, where, and how fast the materials are discharged into the sea; the nature of the discharge (its temperature, salinity, concentration of solids); and, finally, what is done with the nodules that are collected or discarded.

From the *Oceanographer*, DOMES scientists will track the surface plume as it leaves the mining ship. They will try to define the growth of the plume in three dimensions, by collecting water samples and analyzing them for telltale traces of effluent material, making measurements of the clarity of the water at different places, and probing the water with sonar. The shipboard scientists hope to supplement their observations with images from satellites.

Even after the mining test has ended, the DOMES research will continue, watching the site to see how it recovers, and how long the process takes. The NOAA scientists plan to remain on the site for a period following completion of the mining test, as the sediments settle again to the bottom or are dispersed by the currents; and will return for followup studies at several-month intervals for as long as mining effects persist.

On later mining tests, the DOMES scientists hope to monitor the effects of the dredgehead on the sea floor, and the waste plume discharged into the bottom waters. They want to observe how rapidly the collector moves across the bottom, how its movement clouds the waters, and how deep a scar it leaves. In addition to the same observations used to track the surface plume, the scientists will collect bottom samples, and lower underwater cameras to record events on the sea floor.

Violation Notices Given 30 Tuna Vessel Skippers

Notices of violation, carrying possible fines up to $10,360, have been issued to 30 skippers of U.S. yellowfin tuna purse seine fishing vessels—most from the west coast—for failing to follow regulations governing their activities in 1976, the National Oceanic and Atmospheric Administration (NOAA) has announced.

NOAA's National Marine Fisheries Service, which issued the notices, said most of the violations were for failure to use proper porpoise-saving procedures while fishing. Other notices of violation were issued for not having certificates of inclusion (which permit the fisherman to take porpoises in association with the yellowfin tuna), and failure to report as required.

The amount of a fine is determined by a complex formula based on points for procedural violations assessed against a skipper, the number of porpoises killed per set by the skipper, and a comparison to the fleet average of the number of porpoises killed per set.

Observations were made on 747 sets of which more than 92 percent were carried out in compliance with regulations. Lack of the required two manned speed boats to hold fishing nets open accounted for more than 73 percent of the violations, while others included failure to use two rescuers continuously to asssist porpoise out of nets, failure to release porpoises by hand continuously, the use of sharp pointed instruments in removing the porpoises, and failure to use required boat maneuvers when the porpoises were in the net.

Skippers may elect to pay a fine, request a hearing to seek relief from the fine, or accept a compromise fine through administrative procedures in lieu of a hearing.

Mexican Fishery Development Plan Aims to Hike Fish Production 300 Percent in 6 Years

Mexican Fisheries Director Fernando Rafful has released the details of the new National Fisheries Development Program after conferring with President Lopez Portillo and presenting the Plan to the Mexican Congress on 4 August. The Plan is designed to advance Mexico's present position as the world's 28th most important fishing nation to the world's 5th-ranked fishing country.

Mexico has a 10,000-km coastline and its new 200-mile Exclusive Economic Zone (EEZ) covers an area of over 2 million km². The country's fishing industry is now dominated by fisheries for species primarily destined for export, such as shrimp, lobster, and abalone. The new Fisheries Development Plan provides an increase in Mexico's fishery landings of over 300 percent, from about 0.55 t in 1976 to 2.4 million t by 1982, as well as an increase in the availability of fishery commodities on the domestic market.

To accomplish this, the Mexican government has proposed an investment of $1.3 billion from government and private domestic and foreign sources, which is more than double the figure mentioned in previous reports. The Mexican government was also considering revising the laws governing foreign investment. Rafful stated that the Plan aims at transforming Mexico into a modern fishing nation by expanding the fleet, constructing new fishing ports and processing plants, and improving the organizational and financial structure of the industry.

The largest portion of the $1.3 billion planned investment will be used to expand the fishing fleet. The government has allocated $526 million, or over 40 percent of total planned investment, for the construction of 993 vessels. This includes 106 tuna boats, 62 sardine/anchovy seiners, 616 shrimp trawlers, 82 groundfish trawlers, 4 large stern trawlers, 12 medium hake trawlers, 10 red crab trawlers, 1 seaweed harvester, and 100 snapper/grouper smacks. Only 339 shrimp trawlers and 4 tuna boats are to replace existing vessels, the rest will be deployed in the expanding fleets.

The Mexican government has traditionally attempted to discourage vessel imports and to promote the purchase of fishing vessels from domestic shipyards. The 500 shrimp trawlers financed by the Mexican Government during the Echeverria Administration for cooperative fishermen were all built in Mexican shipyards.

The new Lopez Portillo Administration, however, has received, many requests from private and cooperative fishermen for permits allowing the importation of foreign-built fishing vessels. After approving import licenses for 21 used Peruvian anchovy seiners in January 1977, the Government suspended further vessel imports, pending the completion of a study to determine if Mexican shipyards can meet the country's demand for fishing vessels. Although Mexican shipyards have considerable expertise in constructing shrimp trawlers and have begun to build tuna boats, it is unlikely that they have the capacity to build all of the vessels envisioned in the Plan by 1982.

Aquaculture and freshwater fisheries development received the second highest priority from the Department of Fisheries with a planned investment of $239 million. Mexico has more than 5 million acres of inland waters and the Government believes that landings can be increased 780 percent to 660,000 t by 1982, amounting to 25 percent of Mexico's projected total fishery landings in that year. Part of this investment will finance the building of 24 aquaculture centers, 42 intensive-culture fish farms, and 100 pilot fish farms.

Most of the expanded aquaculture and freshwater catch will be food fish for the domestic market. Recent press reports have indicated, however, that a new experimental shrimp aquaculture project will be built at Puerto Peñasco at the northern tip of the Gulf of California. The project will utilize new methods developed by the University of Arizona and the University of Sonora and is being partially funded by the Coca Cola Company.

Another priority program under the new Plan is a $177 million investment to develop needed fisheries infrastructure, primarily the construction of fishing ports. A total of 160 fishing ports are planned, 60 on the Gulf of Mexico and 100 along the Pacific coast.

JAPAN PLANS HUGE ARTIFICIAL REEF

A gigantic artificial reef, as much as 20 times the size of any currently in existence in Japan, is reportedly being planned off the coast of Yamaguchi Prefecture in a 3-year program beginning in FY 1978. The reef would provide a fishing ground for yellowtail, jack mackerel, Pacific mackerel, and snapper, according to the program. Initial construction will place eight 10-cubic-meter and 1,000 2-cubic-meter concrete blocks along with a seaweed bed consisting of 4,000-cubic-meter quarry rock on a sea bed from 70 to 80 meters deep off the City of Hagi.

By the end of the FY 1980, the reef will be enlarged to five times the initial size at a cost of approximately $1.9 million. (Source: Foreign Fishery Information Release No. 77-10).

Priority has been assigned to the traditional fishing ports of Alvarado, Tuxpan, Tampico, Ciudad del Carmen, Mazatlán, Guaymas, Salina Cruz, and Ensenada. Plans also call for investments in roads, trucks, refrigerated vans, communication facilities, water and power supplies, maintenance and repair facilities. The Plan also addresses one of the major problems limiting the growth of the Mexican fishing industry, namely the lack of an adequate national distribution and marketing system. Significant quantities of fish are consumed only along the coast and in a few large inland cities. The government now plans to invest $142 million to provide the distribution and marketing facilities needed for a wider distribution of seafood commodities. A better distribution of sardine, anchovy, shark, oyster, and octopus catches in the states of Colima, Michoacan, Chiapas, Tamaulipas, Veracruz, and Tabasco has priority under the Plan. Other investments provided for under the new Plan include $146 million for industrial development and transportation, and $70 million for research and training.

Rafful has indicated that the Plan will create 100,000 additional jobs in the fishing and fishery-related industries. Most of the increased catches envisioned in the Plan will come from Mexico's 200-mile Exclusive Economic Zone and inland water. The catches of tuna, cod, hake, squid, and cuttlefish, however, are projected off the coasts of other countries or in international waters. Mexican consumers now eat about 230,000 t of fishery products annually. The Government hopes to increase this consumption to nearly 895,000 t by 1982 and also to promote the buying of species which are in abundant supply in Mexican waters, but unfamiliar to Mexican consumers. Special emphasis will be placed on marketing species such as anchovy, squid, cuttlefish, crayfish (langostilla), and hake, which are currently underutilized by Mexican fishermen and consumers.

Productos Pesqueros Mexicanos (PROPEMEX), a state-owned production and marketing enterprise, has posted invitations for bids in several Mexican newspapers following tentative approval of the Fishery Development Plan's Budget. To qualify for bidding, firms or persons must be on the approved list of Government purveyors.

The invitation is divided into four major classifications: 1) Fishery vessels and other vehicles, auxiliary equipment and gear, electronic, communication, fishing gear, etc.; 2) production—processing and packing equipment for fishmeal plants, refrigeration equipment, boilers, compressors, pumps, filters, scales, etc., laboratory equipment, industrial gases and chemicals; 3) maintenance—electrical motors, breakers, starters, transformers, electrical material such as wire, conduit, lamps, pulleys, belts, valves, controls, pipe, stainless tubing, hoses, etc; 4) others—forklifts, trucks, panel trucks, diesel engines, tools, lubricants, construction material, safety equipment, office equipment, construction material, etc.

Interested firms must register with PROPEMEX as soon as possible at their Mexico City office: Gerencia de Adquisiciones, Avenida Baja California No. 255-A, Colonia Hipodromo Condesa, Mexico, D.F. U.S. firms should notify their Mexican representatives to take the necessary action.

According to the NMFS Office of International Fisheries, there is no doubt that Mexico's fisheries catch can be substantially increased. Whether Mexico can achieve its goal of increasing the fishery landings to 2.4 million t by 1982 is an open question. Such a large increase in 6 years would be an astounding achievement by any country. While considerable development of the country's fisheries was accomplished during the Echeverria Administration (1971-1976), the rate of growth never approached the rate which would be required to reach 2.4 million t by 1982. Between 1970 and 1976 the Mexican fisheries catch increased at an average rate of under 20 percent annually. The projected annual rate of growth in the new plan is about 55 percent.

Numerous problems still plague the Mexican fishing industry. The large state-controlled corporation has amassed multi-million dollar deficits which continue to increase. Bitter conflicts divide the private and cooperative fishermen. Many cooperatives are hopelessly in debt and accusations of corruption are commonplace. Existing laws impede needed foreign investment. Much of the industry is centered on export markets and provides only a few low-priced foods to the domestic consumer. The important Pacific shrimp fishery is being overfished and large amounts of shrimp are being sold illegally. To solve these and other problems by 1982 and to increase the catch by 300 percent will require a phenomenal performance by the new Department of Fisheries.

Rafful, has apparently succeeded in winning the confidence of many Mexican business and cooperative leaders. The coordination of the many diverse government agencies which previously dealt with fisheries will help the government to formulate and implement a coherent national fisheries policy. The new Fisheries Development Plan appears to be a well-conceived program designed to modernize the industry as well as to alleviate some of the problems which have plagued it. The Mexican Congress was expected to approve the Plan with only limited revisions. Many informed observers believe that even if the catch goal of 2.4 million t is not achieved by 1982, the Mexican fishing industry will undergo the most significant period of growth in its history. (Source: IFR-77/158).

Russia, Japan Okay Fish Quotas in Japan's Waters

The Soviet-Japan Interim Fisheries Agreement which regulated the Soviet fishing in waters under the Japanese 200-mile jurisdiction from July through December 1977 was signed in Tokyo on 4 August. The agreement allocated a catch quota totaling 335,000 metric tons to 276 Soviet vessels for the period. During the negotiation, the Soviet delegation surprised the Japanese by revealing that the Soviets had caught 635,000 tons the previous

year in the Japanese coastal waters (or 487,000 tons from July through December), more than twice the amount the Japanese government had estimated. The catch quota allowed to the Soviet Union by the new agreement, therefore, would represent a 31 percent reduction when compared with the Soviet-claimed figure for the comparable 1976 period, but an increase of as much as 50 percent when compared with the original Japanese estimate.

Alaska pollock, with a 30,000-ton catch quota, received the largest cut of all fish species, by as much as 108,000 tons or 78 percent from the Soviet-claimed figure of 138,000 tons during the comparable year-earlier period. The agreement further stipulated a restriction to Alaska pollock fishing by imposing a year-round ban on bottom trawling at depths less than 500 meters in all of the 200-mile zone waters and inside of the "otter line" off the Pacific coast of Hokkaido.

In the new agreement the Soviet Union apparently emerged with much of its fishing rights for sardines and mackerel intact, the species in which they have a strong interest. The agreement allowed a combined catch quota of 200,000 tons for these species, only 11 percent less than the comparable 1976 catch total of 224,000 tons. Furthermore, catch allowance of up to 10 percent was recognized for sardines and mackerel, provided that the increment be contributed from the quotas for other species. The 276 Soviet vessels admitted into Japan's 200-mile zone represents a cut of approximately 10 percent from a year ago.

The delegations of the two governments are scheduled to meet again in late August to begin negotiations for a long-term fisheries treaty. A breakdown of catch quota for July through December 1977, is shown below in comparison with actual catches for the comparable 1976 period. (Source: Foreign Fishery Information Release No. 77-11.)

Species	1977 Quota	1976 Catches
Sardine, mackerel	200,000 t	224,000 t
Alaska pollock	30,000	138,000
Itohikidara (Remonema)	58,000	66,000
Saury	10,000	0
Sand lance	4,500	30,000
Others	32,500	29,000
Total	335,000	487,000

PRC, Japan Exchange Fishery Visits

The executive secretary of the Sino-Japanese Friendship Association, Sun Ping Hua, told a group of Japanese visitors in Peking in early August 1977, that the PRC was carefully examining her relationships with neighbor nations on the issue of a 200-mile fishery conservation zone. The visitors were fishermen from Shimonoseki City, located in the western part of Japan.

Hua maintained that the PRC (People's Republic of China) would not establish a 200-mile zone in the near future, and that when it did, it would not draw the 200-mile line unilaterally. The North Korean 200-mile zone measures had taken effect only a few days earlier, and Sun expressed approval, though he reportedly criticized the Soviet establishment of a 200-mile zone.

Hua's statements somewhat alleviated the Japanese fishermen's concerns. However, the fishermen were aware that the PRC had begun to be active in fishing operations in the East China and Yellow Seas. Giant Japanese fishing companies are selling fishing vessels to the PRC, while the PRC has stepped up her own fishing vessel construction program. Besides, the South Korean fishermen have been driven out of the North Korean and Soviet 200-mile zones. The western Japanese fishermen fear that the PRC would not lose any time in setting up her own 200-mile zone if South Korean fishermen increase their efforts in the East China and Yellow Seas.

A 40 member western Japanese fisheries delegation led by Governor Kamei of Fukuoka prefecture visited the People's Republic of China in Late October 1977. Each of the four prefectures represented in this tour were to select six fishing industry leaders and four prefectural and municipal government administrators to participate. Earlier this year, 451 Japanese businessmen and community leaders, including 18 leaders of the nation's fishing industry, visited the PRC for 2 weeks, touring Shanghai, Yentai, and Peking.

Between 12 July and 3 August, an 11 member delegation of the PRC Fisheries Association, lead by the president of the Association, Hsiao Ho, visited Japan. Although the visit was arranged through a private organization, the Japanese Government was interested in the visit, and Director Okayasu of the Japan Fisheries Agency interviewed the visitors for 1 hour on 30 July.

Besides attending receptions and other special events in their honor, the delegation visited the following facilities: 1) Fishing harbors in Choshi, Misaki, Nagasaki, Shimizu, and Shimonoseki; 2) fish processing centers in Karatsu and Tokusui; 3) aquaculture sites at Kanagawa Prefectural Fisheries Laboratory, Nagasaki Prefectural Aquaculture Research Laboratory, Shiki Shinmachi Aquaculture Center, Western Japan Regional Fisheries Center, and Yamaguchi Prefectural Mariculture Center; 4) Nagasaki, Kinshi and Tokushima shipyards; and 5) the Japan Specialty Steel Company and the Yanmar Diesel Engine Manufacturing Company.

The PRC has requested the Taiyo Gyogyo Company of Japan to sell eight trawlers engaged in operation in the sea regions to the west of the Japanese islands. Taiyo recently obtained Japanese Fisheries Agency clearance as well as an understanding by the fishing industry, and will export to PRC five 11-year-old, and three 7-year-old trawlers.

Taiyo has also signed a contract with PRC for the sale of a 5,000 t refrigerated transport vessel *Yuyo Maru*. The vessel, which underwent maintenance service, was scheduled for delivery to PRC officials at the end of September 1977 at the port of Sasebo, Japan. Seven PRC engineers were trained in Japan on the handling of the vessel's engine and gear.

Six refrigerated transports, 850 GT each, were built and exported to the

People's Republic of China by Kinshi Shipyards of Japan between April and October 1974. Each of the vessels was 67.15 m long, 10.90 m wide, had a full load draft of 4.50 m, took a 40-man crew, and was capable of cruising at 12 knots fully loaded.

The vessels were not equipped to fish, but had pumps for transferring fish from other vessels or purse seines and have jet devices to provide crushed ice directly to the satellite vessel holds. Three refrigerated transports of 2,000 GT each and capable of supplying oil and other necessities to fishing vessels were also constructed and delivered to the PRC by the same company in December 1975.

The president of Taiyo returned from the PRC on 5 July 1977 and held a news conference on his 8-day courtesy visit. He disclosed that his company was to purchase about 500 t of Yellow Sea prawns from PRC fishermen in Po Hai Gulf between September and November 1977. The high seas transloading was first attempted in 1976, and 50 t of the PRC-caught fresh prawns were marketed in Japan.

Taiyo's president also planned to buy fur products from the PRC and exhibit them in Tokyo, Osaka, and Sapporo for marketing. In response to his questions concerning PRC 200-mile zone legislation, PRC officials assured the president of Taiyo that they wished to continue the friendly fisheries relationship with Japan. They said that while the fisheries conservation efforts must be directed to each species, the historic Japanese catch levels would be taken into account when PRC established its 200-mile fishery conservation zone.

In 1974, Japanese importation of PRC fishery products reached the record high annual volume of 39,000 t, valued at 29 billion yen (US$107.4 million). Since, the imports declined steadily both in volume and in value until recently. Japan imported from PRC only 13,000 t of fishery products valued at 9 billion yen (US$33.3 million) during the first half of 1977. More recent reports, however, indicate a gradual increase in the PRC exports to Japan. High quality sea urchin roe and fresh clams contribute to this upswing in the fisheries trade.

Although the trade in fish between the two neighbor nations declined, the exchange of fishery technology has not diminished. On the contrary, PRC has intensified her efforts to obtain assistance from Japanese fishing companies to develop her fishing, and aquacultural and fish processing technologies. There are possibilities of the establishment of a bilateral governmental technical cooperation scheme involving fisheries. Table 1 shows Japanese imports of PRC fishery products in 1975 and 1976. (Source: Report 77-5, NMFS Language Services Branch.)

Table 1.—Japanese imports of PRC fishery products, 1975-76, by quantity (t) and value (million yen)[1].

Products	1975 Quant.	1975 Value	1976 Quant.	1976 Value
Live fish				
Eels	34	386	24	962
Fresh or frozen				
Spanish mackerel	1,831	380	1,000	319
Prawns	9,768	13,996	5,577	12,763
Clams	7,141	1,018	10,040	1,748
Other	3,285	981	4,078	1,056
Salted or smoked				
Herring roe	1,116	1,726	1,447	3,844
Jellyfish	3,286	1,781	1,247	836
Other	178	49	156	48
Regulated items				
Crabs, squid, etc.	6,607	1,480	7,248	1,937
Other	1,662	434	842	180
Total	34,910	22,651	31,661	24,750

[1]One million yen = US$3,700.00 at the exchange rate of 270 yen = US$1.00.

Russians, Danes Explore A Joint Fishery Venture

Denmark's Fisheries Minister, Svend Jakobsen returned from a 6-day summer visit to the Soviet Union and told the press that Denmark sought an agreement with the Soviet Union whereby Soviet-caught reduction fish would be landed in Danish ports to be processed by the Danish fishmeal industry. Jakobsen also proposed that food fish be landed in Denmark and then re-exported to the Soviet Union. Also discussed was the possibility of Denmark building and selling fishing vessels and gear to the Soviet Union. The Soviets appeared, however, to be more interested in obtaining drydock facilities for routine overhaul and repairs of their fishing fleet.

There was at first some concern that the Soviet Union would have to sign a fisheries agreement with the European Economic Community (EEC) before concluding a joint fisheries venture with EEC member Denmark. Soviet refusal to recognize the EEC and, more specifically, its jurisdiction in West Berlin, had complicated previous Soviet-EEC fisheries negotiations. According to more recent information, however, the joint venture proposal was judged to be a private arrangement which did not require prior Soviet recognition of the EEC. Although Danish Fisheries Minister Jakobsen carried out the original negotiations, the joint venture proposal was in fact initiated by the leaders of the Danish fish processing industry.

According to the NMFS Office of International Fisheries, the Danish fish meal industry is threatened by the prospect of inadequate supplies of fish. The recent decision by the European Commission to ban herring fishing temporarily further accentuates the problem and may, in the long run, force the Danes to use other species for reduction. Danish fishmeal plants on Jutland's northern coast will be particularly affected, and unemployment in the area is certain to rise. Strong demands have been made on the Danish government to provide grants to to fishermen totaling US$5 million and to seek a solution that would maintain Danish supplies of reduction fish.

The possibility of Danish shipyards exporting fishing vessels and gear to the Soviet Union, would not be new in Danish-Soviet fishery relations. The Soviet Union has a history of vessel contracts with the Burmeister and Wain shipyard in Copenhagen that dates back to 1932.

By 1960, the Soviets had already purchased about 20 freezer trawlers from that shipyard. In the course of the 1960's and early 1970's, this figure doubled with Soviet purchases of 21 refrigerated transport/freezer trawlers

of the SKRYPLEV-GRUMANT class. The first four vessels, constructed during 1962-1963, were of the SKRYPLEV class and were designed primarily as freezer vessels. The remaining vessels, constructed between 1964 and 1971, were all part of the GRUMANT class, which was based on the SKRYPLEV design with the addition of trawling equipment.

Until the late 1960's, the B and W shipyard was the Soviet Union's only supplier of these types of freezer vessels. However, when Dutch shipyards became capable of constructing similar vessels, the Soviets contracted for several vessels of the related REMBRANT series and the first deliveries of these took place at the end of the decade.

Trade between the B and W shipyard and the Soviet Union was not limited to vessels alone. In 1959, cooperation between the two was expanded by the issuance of a license whereby the Soviet Union could build B and W diesel motors. Since then, many of the vessels built in Soviet shipyards have been equipped with Soviet-built models of B and W motors.

Some of the reasons why the Soviets now appear to be more interested in obtaining drydock facilities in Denmark for routine overhauls and repairs of their fishing vessels rather than purchasing Danish vessels and gear may be that: 1) the Polish and East German shipyards can fill Soviet vessel orders more cheaply; 2) Soviet shipyards themselves can produce comparable vessels and gear; and 3) the Soviet Union has reoriented its fisheries investment program toward improving shore-based processing facilities, ports, and the retail market network for fishery products rather than further increasing the size of its already large fishing fleet. (Source: IFR-77/166.)

Japan To Boost Aid For 200-Mile Zone Program

The Japanese Ministry of Agriculture and Forestry, in late summer, disclosed a draft budget request for FY 1978 containing a proposal to increase fishery-related spending by an average 27 percent over the current FY 1977 budget. The requested total government spending in the fisheries sector for FY 1978 is ¥224,400 million (US$865 million at ¥260 = US$1).

A program receiving a special emphasis in the FY 1978 fisheries budget is the development of fisheries within Japan's own 200-mile zone, for which a sum of ¥18,688 million (US$72 million) is allocated. This program, which ranked a distant second behind one aiming to protect Japanese fishery rights in foreign waters in 1977, has been given a spending boost of about 70 percent to attain a significant status in substance. The draft budget request was submitted to the Finance Ministry to be incorporated into the overall government budget request which was to go to the Diet for legislative approval early in 1978. (Source: Foreign Fishery Information Release No. 77-12.)

Artificial Spawning of Milkfish Reported

Philippine press reports indicate that a team of Filipino and foreign fishery researchers have succeeded in inducing artificial spawning and hatching if viable larvae of the sabalo (*Chanos chanos*), also commonly called bangus or milkfish. This was reportedly accomplished in the laboratories of the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC) in Pandan, Antique.

The artificial spawning procedure involves injecting the female milkfish at regular intervals with a hormone solution to induce maturing. The milkfish are a sensitive breed and are notorious for refusing to spawn in captivity. Once the eggs were stripped from the female they were mixed with sperm from the male milkfish.

Despite its experimental stage, this breakthrough in artificial spawning could have a significant economic impact on the Philippine fishpond industry which is earning approximately US$135 million and is primarily based on milkfish culture. Philippine milkfish production, under natural conditions, has been close to 100,000 metric tons per year since 1969, according to FAO statistics. It is estimated, however, that it will be 5 or 6 years before refinement of the artificial spawning procedure would allow the production of milkfish fry on a commercial scale. (Source: IFR-77/163.)

Japan Reports 1975 Tuna Catch Within 200 Miles of Foreign Coastlines

In 1975 as much as 46.7 percent of the total Japanese longline tuna catches came from within 200 miles of foreign shores, according to a *Suisan Shuho* report. Operating in those waters, 750 tuna longliners belonging to members of Nikkatsuren (Japan Association of Tuna Vessel Owners) harvested 136,200 t of tuna by longlining. The following table gives details on the harvest by country and by species. The table does not include results of the 1975 skipjack pole-and-line fishery.

Japan's 1975 longline tuna catches within 200 miles of foreign shores (in metric tons).

Country	Bluefin tuna	Albacore	Bigeye tuna	Yellowfin tuna	Other tuna	Marlin	Other[1]	Total
Australia	4,440	840	1,200	1,890	8,370	2,700	870	11,950
Equador	—	—	9,690	2,140	11,830	1,360	360	13,550
Indonesia	30	210	4,510	5,140	8,900	890	260	10,100
Mexico	160	—	—	1,370	1,500	4,150	190	5,730
Micronesia	190	810	11,400	14,270	26,670	2,190	1,210	29,980
New Zealand	4,740	120	180	80	5,120	370	510	6,000
Philippines	—	70	1,100	4,240	5,400	260	50	5,730
Portugal	1,970	140	2,670	1,440	6,220	380	200	6,790
South Africa	820	100	270	2,220	3,410	190	150	3,730
United States	1,290	590	3,100	1,680	6,660	680	550	7,900
Total	17,280	3,520	49,480	40,600	110,880	18,860	6,370	136,200
Value[2]	223.1	8.1	322.0	207.0	760.0	105.5	16.6	883.0

[1]Included are 60 t of skipjack and 485 t of shark.
[2]Yen, in millions (US$3.33).

Foreign Fishery Market Reports Published

Several reports on the fishing industries, companies, and markets of foreign nations have been prepared by U.S. foreign service posts and can be purchased from the National Technical Information Service (NTIS). Two of these reports are reviewed here; the others are listed below.

Country	Title	Pages	Order No.	Price
Brazil	"The Fishing Industry in Brazil"	16	DIB 77-03-004	$3.50
Burundi	"Fishing Industry"	3	DIB 77-02-025	$3.50
Ecuador	"Fisheries"	14	DIB 76-11-014	$3.50
Germany (FRG)	"German Squid Market"	5	DIB 77-03-032	$3.50
Japan	"Direction of Technological Development" (Hatcheries and Stock Preservation)	21	DIB 76-06-012	$3.50
Mauritania	"Fishing Companies"	20	PB 261-862	$3.50
Panama	"Fishing Industry"	26	DIB 76-09-027	$4.00
Philippines	"Philippine Fishing Industry Developments"	5	DIB 77-03-002	$3.50
Sweden	"Fishing Industry"	3	DIB 76-02-002	$3.25
Sweden	"Fishing Industry"	7	DIB 76-09-017	$3.50
Sweden	"Fish and Fish Products"	7	DIB 77-05-015	$3.50
Taiwan	"Fishing Industry"	8	DIB 77-02-031	$3.50

GERMAN SQUID MARKET

The market for squid in the Federal Republic of Germany (FRG) is limited. The amount of squid sold in West Germany, currently about 771 metric tons per year, depends primarily on the number of foreign guest workers from Mediterranean countries employed in the FRG. During the past two years, about one-third of foreign squid sold in the FRG was Pacific *Loligo* squid imported from the United States. German importers are interested in receiving offers for U.S. east coast squid, chiefly the *Loligo* variety, to assess its market potential in the FRG. This 5-page report, document number DIB-77-03-032 ($3.50), is sold by NTIS.

PHILIPPINE FISHING INDUSTRY

The climate for U.S. investment in the Philippine fishing industry has improved slightly in recent years. New regulations have placed the industry under government control and the exploitation of resources can only be carried out by Filipino citizens and companies incorporated in the Philippines. There are opportunities for the sale of U.S. marine engines, navigational equipment, and used fishing vessels, but competition with Japanese companies is strong and growing. Opportunities also exist for U.S. suppliers of equipment and components for ice plants and cold storage facilities. Philippine commercial fishing associations have recommended that the government promote the construction of shipyard facilities, cold storage plants, and canneries. If the government takes action on these requests, additional investment opportunities would be created for U.S. companies. This report, DIB-77-03-002, can also be purchased for $3.50 from NTIS.

The following reports, prepared by U.S. diplomatic posts, can be ordered from NTIS, U.S. Department of Commerce, Springfield, VA 22161. Include Document (Order), Number, and make checks payable to NTIS.

Chilean Fisheries Article Translated

"Chile: Its Marine Resources and Their Potential," has been translated from *Hispano* and evaluated by Rolf Juhl, U.S. Regional Fisheries Attache for Latin America. Chile's fishery resources and potential and the government's new fishery policy are reviewed. To obtain a copy, send a self-addressed mailing label to the Language Services Branch, F412, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235.

A Guide for Part-Time Inshore Fishermen

Publication of **"Making a Living Alongshore"** by Phil Schwind has been announced by the International Marine Publishing Company, Camden, ME 04843. It is a how-to-do-it book for small-time or part-time commercial fishermen, although marine sport fishermen would also get a lot out of it.

Well illustrated, the book tells briefly about the gathering and marketing of numerous inshore fishes. Chapters include Commercial Surf Fishing, Flounder Dragging, Eel Potting, Spearing, and Skinning, Clam Digging, Quahogging, Scalloping, Blue Mussels, Profitable Predators and Odd Ways, and A Boat for 'Longshore Fishing. It also includes a brief glossary of fishing terms and tells how to make many of the tools and gears for fishing. The 128 page hardback is available from the publisher for $7.95.

Bering Sea Fish and Shellfish Charts Printed

During August-October 1975, and April-June 1976, the National Marine Fisheries Service conducted extensive demersal trawl surveys of the eastern Bering Sea. The results of these two surveys are now available as data sheets that overlay National Ocean Survey Chart No. 16006, showing catch rates (weight per distance towed) at each trawling station.

The data sheets provide a comprehensive picture of the distribution and relative abundance of each resource within the area 54-61°N latitude, 156-176°W longitude. Charts are available for: Total groundfish, walleye pollock, Pacific cod, yellowfin sole, Pacific halibut, red king crab, blue king crab, total tanner crab, tanner crab (*Chionoecetes bairdi*), and tanner crab (*C. opilio*). Charts may be requested from the Bering Sea Project, Resource Assessment Division, Northwest and Alaska Fisheries Center, 2725 Montlake Blvd. East, Seattle, WA 98112. Please specify whether charts for the 1975 survey (538 stations) and/or the 1976 survey (479 stations) are wanted.

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